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RARITAN BAY CONFERENCE, 22-23 AUGUST 1961. REPORT ON POLLUTION OF INTERSTATE WATERS OF RARITAN BAY

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Public Health Service
New York, New York

August 1961

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RARITAN BAY CONFERENCE

August 22 - 23, 1961

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August 1961

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REPORT
ON
POLLUTION OF INTERSTATE WATERS
OF
RARITAN BAY

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FOREWORD

Acknowledgement is made of the assistance provided Public Health Service in the preparation of this report by the following agencies:

Interstate Sanitation Commission
New Jersey State Department of Health
New York State Water Pollution Control Board
New York State Conservation Department
Middlesex County Sewerage Authority
New York City Health Department
New York City Department of Public Works
U. S. Corps of Engineers, New York District
Hq., First U. S. Army
Hq., Third U. S. Naval District

This report is based upon information assembled from the published and unpublished reports and files of the above agencies and such other published information as was available.

INTRODUCTION

The Raritan Bay area for the purposes of this report may be defined as Lower Bay, Arthur Kill, the Narrows, and Raritan Bay proper plus its main tributary, the Raritan River. This region includes parts of both New York and New Jersey. The specific counties included are Richmond in New York, and Middlesex, Monmouth and Union in New Jersey. The 1960 census figures for these counties are Richmond - 221,991, Middlesex - 433,856, Monmouth - 334,401, and Union - 504,255, or a total of approximately one and one-half million people.

Raritan Bay receives drainage directly from Arthur Kill and its tributaries, the Raritan River, and several smaller streams on the New Jersey coast from South Amboy to the Highlands. The area may be more specifically outlined by extending a line from Tremley Point, New Jersey, east across Arthur Kill and through Staten Island to Fort Wadsworth, across the Narrows to Fort Hamilton in Brooklyn, south to Fort Hancock on Sandy Hook, New Jersey, and swinging an elongated arc from Highlands through New Brunswick, and Highland Park, New Jersey, back to Tremley Point.

The bay area, comprised of Raritan and Lower Bays west of a line drawn from the center of the Narrows to Sandy Hook has an approximate area of 30 square miles, half of which is in New York

The depth of the water in Raritan Bay varies from 7 - 22 feet, and in Lower Bay from 7 - 25 feet, with the exception of the channels which are dredged to depths up to 40 feet. By and large the bay areas are shallowest

in their western extremities. In Raritan Bay the average mean low water depth is approximately 10 feet, and in Lower Bay it is approximately 18 feet. The mean tidal range is 4.9 feet.

The principal river emptying into Raritan Bay is the Raritan River which drains an area of 1105 square miles in New Jersey. The Raritan River is navigable as far as it is tidal, from its mouth to a point above New Brunswick, a distance of about 15 miles. The average daily flow at Bound-brook, New Jersey, is 1184 c.f.s.

Raritan Bay is part of the New York Harbor complex, the largest seaport in the world. Each year thousands of passenger and commercial ships pass through the Lower Bay and up through the Narrows to New York City. Many ships traverse Lower and Raritan Bays to reach the highly industrialized areas of New Jersey centered around the lower portion of the Raritan River and Arthur Kill, the latter a major oil refining district.

Water plays more than an ordinary role in the daily activities of the people in this region. With none of the area's 1.5 million people located more than an hour's drive from this large body of water, it is natural to expect marine activities to be a focal point of business and pleasure. The range of water uses is nearly complete. The Arthur Kill handles more than 100,000,000 tons of cargo each year and is ranked as one of the nation's busiest waterways. The beaches on the ocean side of Staten Island entertained over 700,000 patrons last year, while those on the New Jersey side

were also heavily used. From Sandy Hook Bay across to the mouth of the Raritan River fishing, boating and bathing abound. The need for these water uses has been on the increase.

In the past, Raritan Bay was an important source of shellfish. The area was closed to shellfishing in 1925 and was not reopened until 1934 in New Jersey and 1940 in New York. Since its initial closing in 1925 Raritan Bay has not achieved its full potential for clamming due to water quality conditions.

During the early months of 1961 the incidence of infectious viral hepatitis was high in New Jersey. Some cases of hepatitis were traced to some clams that were taken from Raritan Bay. The New Jersey State Health Department closed the New Jersey portion of Raritan Bay to shellfishing on May 1, 1961. The New York State Conservation Department followed suit on the same date and closed the shellfish beds in New York state.

On the basis of reports, studies and surveys indicating that a water pollution problem existed in the interstate waters of Raritan Bay, and because of the reported hepatitis outbreak associated with these polluted waters, the Surgeon General of the Public Health Service called this conference as a first step under Section 8 of the Federal Water Pollution Control Act of 1956.

Dr. Luther Terry, in announcing the conference, said:

"It ought to be clearly understood that the purpose of the conference

is to deal with the broad problem of water pollution in this area, not solely with the effects of water pollution on clams."

PAST STUDIES

In "The Tempest", Act II, Scene 1, Shakespeare said, "What is Past is Prologue". There are many other ways to express the same basic thought but still the facts remain unaltered. In order to understand the nature of an existing condition one must have a knowledge of its history.

There have been a great many reports written on the waters of Raritan Bay in the past. Several have dealt with water quality and others have dealt specifically with the effects of pollution on shellfish growing areas. The following is a partial listing and brief summary of the more recent of these reports:

1. Southern Arthur Kill Survey - 1955

From 1955 to 1957 the Interstate Sanitation Commission conducted three studies on the water quality of Arthur Kill. The first of these studies took place during September and October of 1955. It was concluded that "There is a negligible amount of fresh water emanating from the Southern end of Arthur Kill", and "that major pollutional sources are 'uphill' of the survey area" (Ottenville).

2. Study of Pollution in Arthur Kill - 1956

The second study conducted in 1955 and 1956 stated that more than 50 percent of the B.O.D. load in Arthur Kill originated in the northern third. It also mentioned that "The use of the Kill as a source as well as a recipient of .... cooling waters tends to increase the temperature

of the Kill above that normally encountered in tidal waters in this area". The report went on to mention that at the lower end of the Kill (a class "A" water), Arthur Kill failed to come up to the Compact standard 30 per cent of the time.

3. Interstate Sanitation Commission Annual Report - 1958

The third study was conducted in June and July of 1957 to determine conditions existing throughout the Kill. Samples were collected and analyzed for dissolved oxygen, chlorides, pH, and temperatures. The results obtained indicated that the Interstate Sanitation Commission Compact requirements for class "B" waters were not being met for 60 per cent of the Kill's total length. The greatest pollution occurred at a point 8.3 miles above Raritan Bay. It was also stated that a "slug" of pollution approximately 6.4 miles in length was located in the Kill. This slug moves "to and fro with the ebb and flood of the tide".

4. Summary Report on the Quality of Waters in Raritan and Lower Bays - 1958

This report submitted by Harold F. Udell evaluated considerable data and presented the following conclusions:

"(1) Bacterial pollution in Raritan and Lower Bays is relatively high at the head of Raritan and the entrance of Lower Bay but decreases steadily, westerly in Lower Bay and easterly in Raritan Bay.

"(2) The organic pollution in Raritan - Lower Bays does not present a problem because of available dilution and effects of natural purification.

"(3) The pollution in Arthur Kill has a degrading effect on the waters at the head of Raritan Bay.

"(4) Pollution contributed by shipping has not been determined.

"(5) Pollution in the waters of the westerly portion of Raritan Bay should be re-evaluated after the Middlesex County Sewerage Authority Treatment plant has operated for a suitable length of time."

5. Review Copy of New York City Water Survey Series, Report No. 3 - Arthur Kill - Kill Van Kull - June 1960

This report was prepared by Hazen and Sawyer for the classification of Arthur Kill and Kill Van Kull by the New York State Water Pollution Control Board. The report summarizes the condition of the waters of Arthur Kill and Kill van Kull as " .... are generally grossly polluted". Further, the report states that " the quality of waters in Arthur Kill and Kill Van Kull at present is almost wholly a function of the sewage and industrial waste load imposed from New Jersey".

6. Recommended Classification of Surface Waters in the Area of and Including West and Lower Bay and Raritan Bay - June 1960

This report was prepared by the New York State Conservation Department - Shellfisheries Management Unit for the New York State Water Pollution Control Board. The report reviewed present conditions in Raritan and Lower Bays and found the following areas to be polluted:

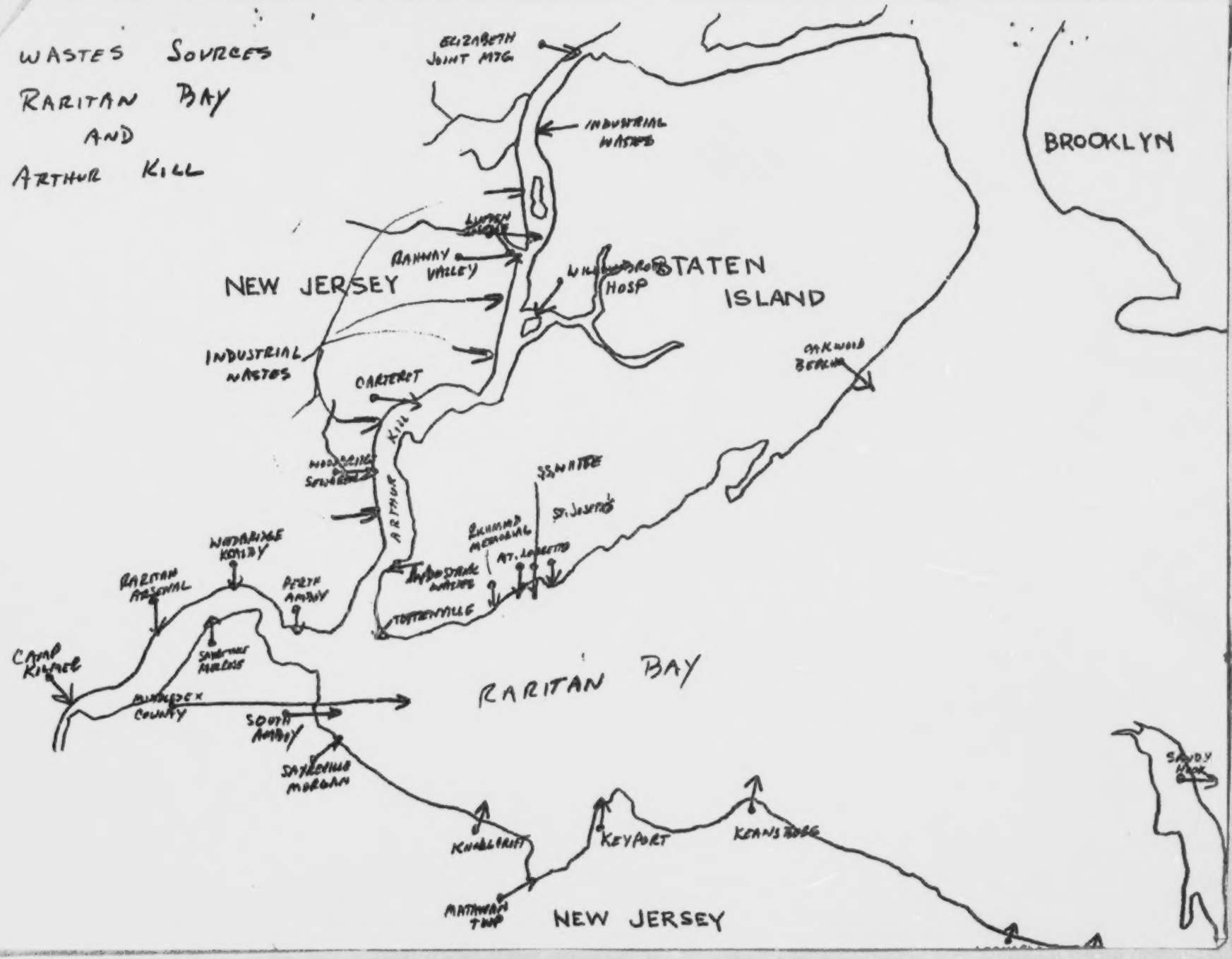
> The waters lying east of a line running in a north-south direction from Great Kills harbor to the New York - New Jersey state line; also those waters of New York State lying west of Princess Bay.

Numerous other reports have been written by local, State and Federal agencies on Raritan Bay and surrounding waters. In general, it may be stated that the conclusions reached by the various authors of these reports have shown that excessive pollution of the waters of Raritan Bay and associated watercourses has resulted from discharges of domestic and industrial wastes from New York and New Jersey.

SOURCES OF POLLUTION

The Raritan Bay - Arthur Kill drainage area includes the Raritan River and its tributaries, Woodbridge Creek, Smith Creek, the Rahway River, all in New Jersey and the Fresh Kills in the Borough of Richmond, City of New York, and a number of small tributary streams in New Jersey. That section of Staten Island draining to Lower Raritan Bay area is estimated at approximately 15,000 acres. The portion of Staten Island draining to the southern section of Arthur Kill is approximately 10,000 acres. The section of New Jersey draining to the Raritan Bay - Sandy Hook Bay complex is estimated at 452,000 acres and the section draining to the Raritan River in that area below the head of tide at New Brunswick is estimated at 194,960 acres. That area of New Jersey draining to the Arthur Kill between the Raritan and Rahway Rivers is estimated at 14,080 acres. An additional [illegible] upstream of the head of tide is sewered by trunk sewers to the Arthur Kill and Raritan Bay areas. This area is estimated at 89,000 acres.

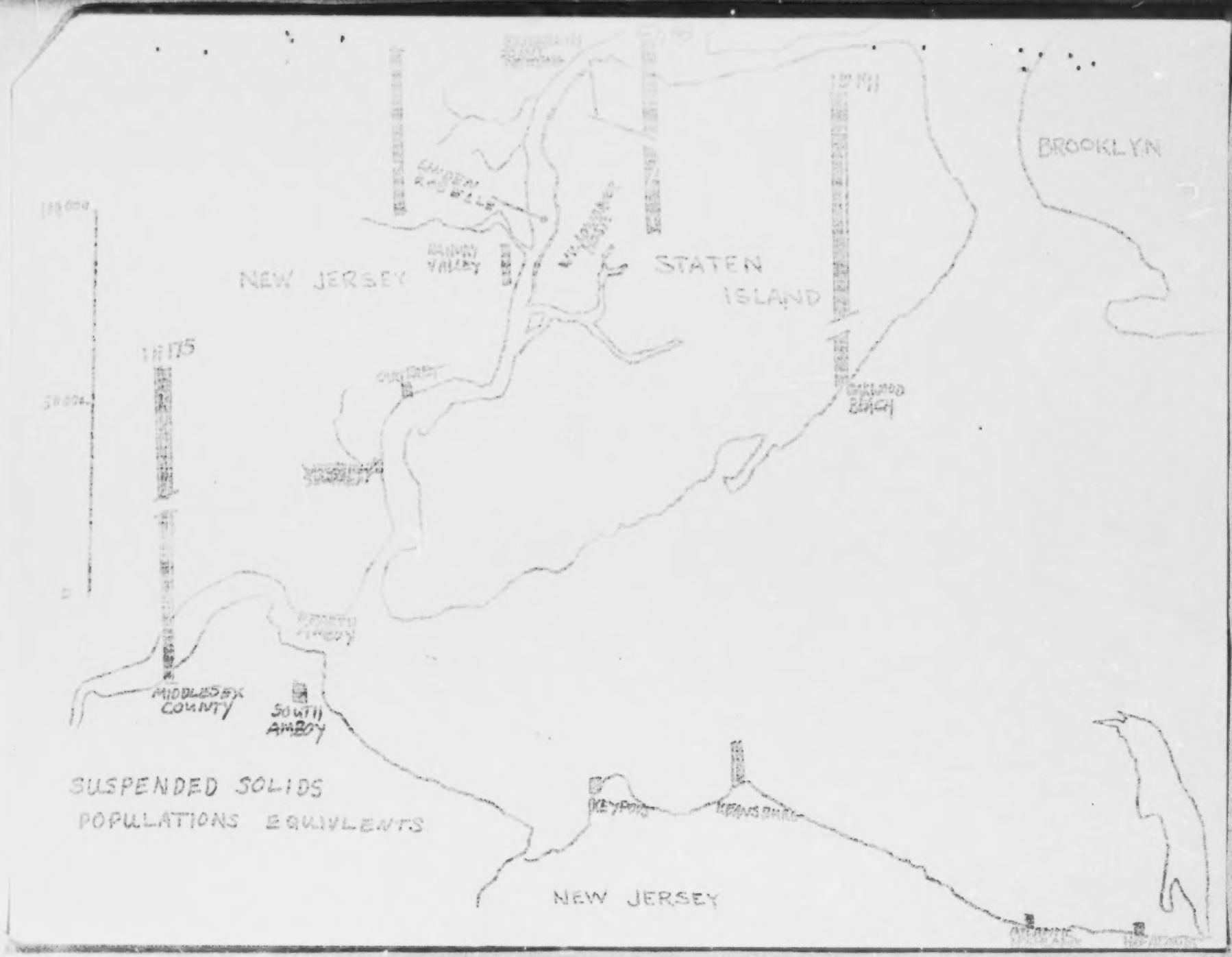
There are more than 70 communities in New Jersey sewered to the Raritan Bay - Arthur Kill drainage area. There is one Borough of the City of New York sewered to this area. The following is a detailed description of each of the discharges to the Raritan Bay - Arthur Kill drainage area. This description includes a summary of available information on the present status of the treatment plant and its adequacy in meeting the prevailing water quality criteria of city, state or the interstate agencies concerned. These facilities are reviewed in a clockwise manner starting with Sandy Hook, New Jersey. Feole No.___ is a summary of the basic data on sources of pollution.

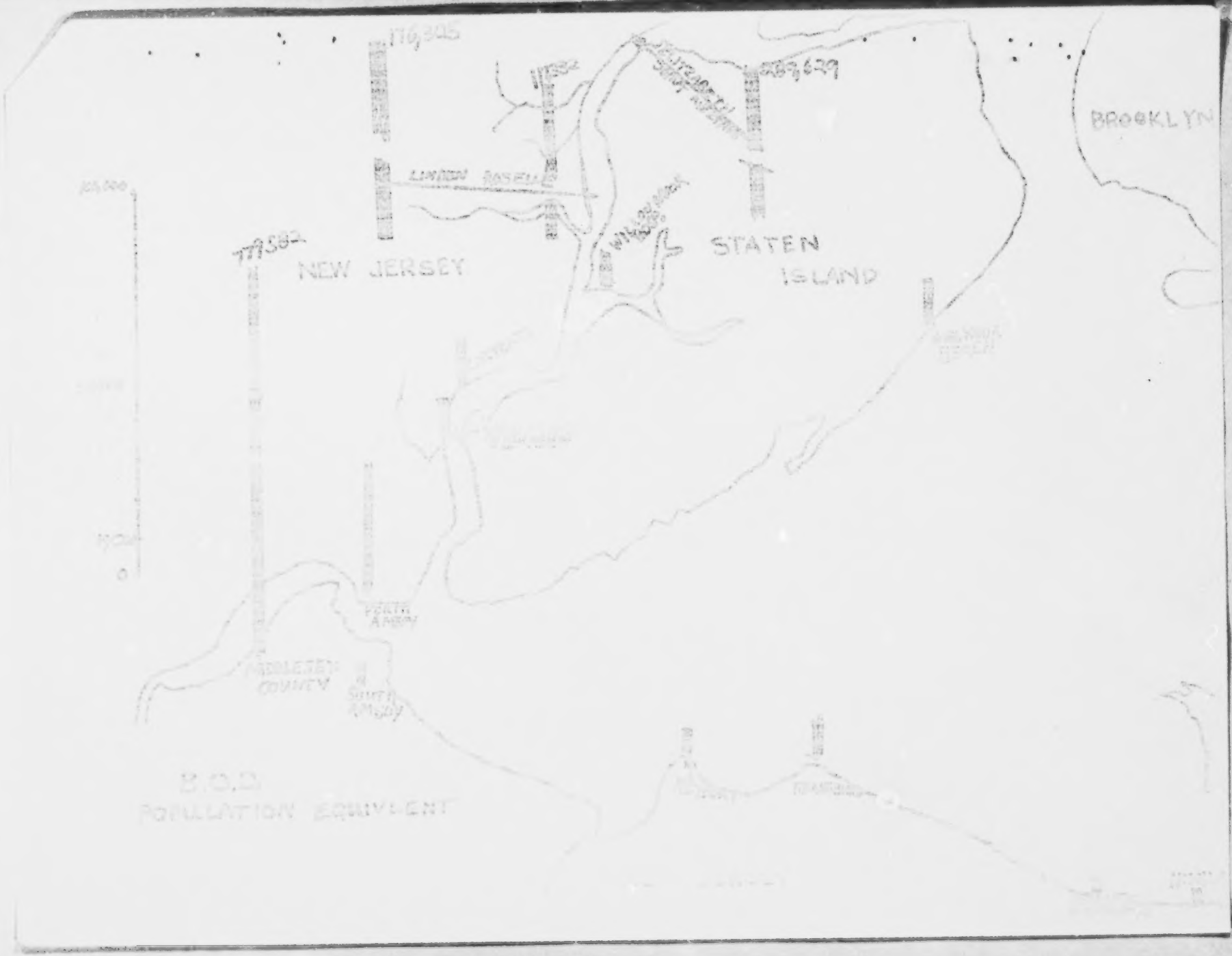

WASTES SOURCES
RARITAN BAY
AND
ARTHUR KILL
ELIZABETH JOINT MTG
INDUSTRIAL WASTE
BROOKLYN
RAHWAY VALLEY
NEW JERSEY
STATEN ISLAND
HOSP
INDUSTRIAL WASTES
CARTERET
OAKWOOD BEACH
ARTHUR KILL
WOODBRIDGE KOMBY
RARITAN ARSENAL
PERTH AMBOY
CAMP KILMER
SAYREVILLE MORGAN
KNOLLCROFT
KEYPORT
KEANSBURG
MATAWAN TWP
NEW JERSEY
RARITAN BAY
SANDY HOOK

MUNICIPALITY OR INDUSTRY	SEWERED POP.	AVERAGE FLOW	DESIGN FLOW	TREATMENT	STREAM
Highlands	5,000	0.4	1.2	[illegible]	Shrewsbury River
Atlantic Highlands	5,100	0.4	0.6	[illegible]	Sandy Hook Bay
Leonardo	330	-	-	[illegible]	Raritan Bay
Keansburg	5,600	1.4	2.0	[illegible]	Raritan Bay
Keyport	5,000	0.8	0.4	[illegible]	Raritan Bay
Matawan	2,700	-	-	[illegible]	Matawan Creek
Matawan Township	1,000	0.13	0.5	[illegible]	Matawan Creek
Hollicroft	650	-	0.2	[illegible]	Raritan Bay
Sayreville-Morgan	2,000	0.1	0.3	[illegible]	Raritan Bay
South Amboy	6,400	0.7	1.0	[illegible]	Raritan Bay
Sayreville-Melrose	1,000	0.05	0.1	[illegible]	Raritan River
Middlesex County S.A.	300,000	40.01	92.0	[illegible]	Raritan Bay
Camp Kilmer	1,100	1.0	6.0	[illegible]	Tributary to Raritan River
Raritan Arsenal	2,700	0.58	-	[illegible]	Raritan River
Woodbridge-Keasby	8,000	0.30	1.35	[illegible]	Lindsey' Creek to Raritan River
Perth Amboy	41,500	7.0	10.0	[illegible]	Raritan River
Woodbridge-Sewaren	21,000	4.2	11.0	[illegible]	Arthur Kill
Carteret	15,000	2.4	5.0	[illegible]	Arthur Kill
Rahway Valley	170,000	22.5	16.7	[illegible]	Arthur Kill
Linden Roselle	120,000	12.2	12.5	[illegible]	Arthur Kill
Elizabeth Jt.Meeting	475,000	52.0	100.0	[illegible]	Arthur Kill
Willowbrook	4,000	0.6	0.6	Cs	Fresh Kills
Mt. Loretto Home #1	1,200	0.09	0.1	Cs	Raritan Bay
Mt. Loretto Home #2	350	0.03	0.035	Cs	Raritan Bay
St. Joseph's Home	200	0.004	-	Cs	Raritan Bay
Marist Fathers	35	-	-	Cs	Raritan Bay
Richmond Memorial Hosp.	300	0.010	0.010	CsHc	Raritan Bay
Oakwood Beach	95,000	9.90	15.0	[illegible]	Lower N.Y. Bay

Key to Treatment Code

A - Aeration
B - Sludge bed
C - Settling tank
D - Digestor (separate sludge)
E - Chlorination
F - Filters
G - Grit chamber
H - Sludge storage tank (not second stage digestion units)
K - Chemical treatment
S - Screens
T - Sludge thickener
V - Mechanical Sludge dewatering
X - Sludge disposal
Z - Sludge conditioning


BROOKLYN
NEW JERSEY
STATEN ISLAND
MIDDLESEX COUNTY
SOUTH AMBOY
SUSPENDED SOLIDS
POPULATIONS EQUIVLENTS
NEW JERSEY


176,325
289,629
BROOKLYN
LINCOLN TUNNEL
NEW JERSEY
STATEN
ISLAND
PERTH
AMBOY
SOUTH
AMBOY
POPULATION EQUIVALENT

FORT HANCOCK, NEW JERSEY

Fort Hancock is located on Sandy Hook. The treatment facilities provided at this base consist of primary treatment and chlorination with a capacity of .5 mgd. The discharge line from this facility discharges to the ocean off the east shore of Sandy Hook and does not enter the waters of Sandy Hook or Lower Bay.

HIGHLANDS, NEW JERSEY

The Highlands treatment plant was built in 1928 to accommodate a design flow of 1.2 mgd. The treatment consists of sedimentation plus chlorination. The treatment units are a bar rack, sedimentation tank, chlorination with a contact tank, and glass-covered sludge beds. The original outfall line traversed the Shrewsbury River and the neck of land connecting Sandy Hook to the mainland, and enters the Atlantic ocean. This outfall line was reported to be broken sometime in the past and, according to the records of the Interstate Sanitation Commission, the effluent is presently being discharged to the Shrewsbury River. The estimated population served is approximately 3,000 persons during the winter and upwards of 6 to 12,000 during the peak summer months. The 1960 Census population for this area is 3,536. Average flow during the winter months is approximately 0.4 mgd.

Inspections by the ISC, since 1950, have shown that the plant failed to comply with the Compact suspended solids removal requirement on 7 occasions out of the 14 visits made by the Commission staff. Removals ranged from a low of 42% on December 20, 1960 to a high of 82% on June 7, 1955. The coliform requirements of the Commission were met on every occasion. The Interstate Sanitation Commission records also indicate that the flow meter and totalizer have been out of order since prior to their April 30, 1958 visit. The records

of the IR? indicate that the product is a polyamide product with an

imsm by-pass.

ATLANTIC HIGHLANDS, NEW JERSEY

Atlantic Highlands treatment plant was built in 1928 for a design flow of 0.6 mgd, providing sedimentation and chlorination. The treatment units consist of a sedimentation tank, chlorination in the wet well on the effluent line, and glass-covered sludge beds. The outfall from this plant enters into Sandy Hook Bay alongside a private marina dock and discharges approximately 1,000 feet off shore. The 1960 estimated population served is approximately 3,000 persons during winter months with approximately double this number served during the peak summer months. The 1960 Census for Atlantic Highlands shows a population of 4,119. The average flow during the winter months is estimated at 0.4 mgd.

Inspections by the ISC since 1958 have shown the plant fails to meet the Compact Standard for suspended solid removal during 9 of the 14 visits that the Commission staff made. The removals range from the low of a negative removal on September 1, 1960, to a high of 77% on May 9, 1961. The plant has failed to meet the coliform requirements of the Commission on 3 occasions during the 14 visits. The plant is operated by a part time operator and, according to the Interstate Sanitation Commission records, the operator was not present during 2 of the 14 visits made by the Commission staff. On various occasions the Commission staff has reported that no operation

records were available at the plant. The tide backs the flow of the treated effluent into the wet-well necessitating pumpage during periods of high tide. The pump on the effluent line was out of operation for a period of several months from December 12, 1960 through March 28, 1961. During that time a portable pump was used to pump the effluent during periods of high tide. Records of the ISC indicate that this is a separate system with no known by-passes. A by-pass at the plant is located in a manhole in the street opposite the plant. This manhole has been well sealed with an accumulation of paving material over the years, indicating that this by-pass has not been used.

U.S. NAVAL ACADEMY MWTP, ANNAPOLIS, MARYLAND

The Severn Naval Depot sewage treatment plant was constructed during the 1940's and consists of sedimentation, filtration and chlorination with a design flow of 0.65 mgd. The treatment units are pre-chlorination facilities, Imhoff tank, sedimentation and filters (out of operation since 1963), and drying beds. The effluent from the treatment plant discharges at Back Creek at its confluence with Whitton Bay. The estimated population served at the present time is approximately 450 persons. The DNR has made 3 visits to this plant since 1958. The plant has met the suspended solids requirement of the Compact on each inspection visit, but has failed to meet the coliform requirement on 2 of the 3 visits.

There are 3 pier facilities on this base with shipboard sanitary facilities located on each of the piers. These sanitary facilities discharge over pierside without treatment. The approximate population using these facilities is 100 persons, with a maximum of 200. Discussions have been held with the Naval Station in charge to obtain compliance with local regulations.

KEANSBURG, NEW JERSEY

The Keansburg treatment plant was rebuilt in 1956 to accommodate a design flow of 2.0 mgd providing sedimentation plus chlorination facilities. The treatment units consist of screens, mechanically-equipped sedimentation tanks, post-chlorination facilities chemical flocculation and sludge digester with vacuum filtration. The outfall line discharges into Raritan Bay, approximately 1500 feet offshore from the city of Keansburg. The estimated population served is approximately 5600 persons during the winter months, with a summer population reaching 3 to 4 times this total during the peak months. The average flow during the winter months is approximately 1.4 mgd. Flows as high as 3.1 mgd have been noted in the TSC records. The 1960 Census population for this community is 6,854.

Inspections by the Interstate Sanitation Commission staff, since 1958, have shown that this plant has failed to meet the Compact requirements for suspended solids removal on 11 of 13 plant visits. The suspended solids removals have ranged from a low of negative removals on 2 occasions to a high of 70% on June 24, 1959. With respect to the coliform standards of the Commission, the plant has failed to meet the standard on 9 of 13 plant visits. Of the 4 visits on which the requirements were met, 3 of these had borderline performances. The records of the Commission note that on May 6, 1959

sludge stored in the digester was hauled away after 2 years of storage. On the occasion of the ISC visit of June 24, 1959 iron wastes were being dumped into the treatment plant at so great a rate that the pumps in the plant could not handle the flow and the plant was observed to be overflowing during the morning sampling period. On that occasion the influent suspended solids was recorded at 2,737 ppm and the effluent at 831 ppm. There is no State licensed operator at this plant, although there is a full time employee designated as the Chief Operator. The records of the Intermunicipal Sanitation Commission indicate that this is a separate gravity system having no known by-passes.

KEYPORT, NEW JERSEY

The Keyport treatment plant was rebuilt in 1958 to accommodate a design flow of 0.4 mgd providing sedimentation plus chlorination. Treatment units consist of a bar rack, sedimentation tank, chlorination facilities, including a contact tank, sludge digestion facilities, glass-covered sludge drying beds. The outfall line discharges approximately 25 feet offshore into Raritan Bay. The estimated population served is approximately 9,000 persons during the winter months and upwards to 3 times this figure during the summer months. The 1960 Census for this area gives a population of 8,242 persons. Average flow during the winter months is approximately .8 mgd. The population served during the winter months is 100% in excess of the designed population of this plant and the flow is 100% in excess of the designed flow.

Inspections of the Interstate Sanitation Commission have shown that this plant failed to meet the assigned MPN requirement of the Commission on 9 of 12 sheet visits. Determined MPN values have ranged from a low of 240 on June 25, 1962, to a high of 700 on November 28, 1962. The plant has failed to meet the Commission coliform standards on 9 of 12 occasions. Records of the Commission indicate that the plant is in very poor condition and is subject to flooding by tidal action. The digestion have been completely out of

operation for some time and the sludge beds have not been used for a period of 2 or more years. The greenhouse is in poor repair with much of the glass broken. During the Commission visit of May 10, 1961 the bar screen was under water during the entire visit and the records indicated that raw sewage had been by-passed through an outfall line on Front Street for a period from May 8 through May 9. The south Keyport pump station was noted as by-passing on April 26. Both of these by-passes were made with the permission of the New Jersey State Health Department. During a visit on April 28, 1961 by the staff of the Interstate Sanitation Commission it was noted that the flow meter was out of operation. The flights for the sedimentation tank had been out of operation since April 13. A septic tank scavenger was removing sludge from the tanks during the period of the visit, the sludge digestion tanks were under water, the chlorine contact tank contained a large quantity of sludge and gas bubbling was observed. The grit chamber-bar rack was surcharged with a flow of water approximately 6" above the tops of the bar rack. The plant was being operated by an inexperienced man from the City Highway Department. The operator was attempting to [illegible] the best he could, but was unprepared for the situation that faced him.

An examination of the sewage system records of the Interstate Sanitation Commission indicates that [illegible] a separate system having

3 pumping stations. One pumping station is equipped with a by-pass overflow arrangement. This is the pump station previously reported as by-passing.

It is understood that the State has this plant under orders and that it is proposed to completely rebuild this plant soon. A project has been submitted under the Construction Grants Program--PL 660 for a grant for the construction of a sewage treatment plant. Additions and improvements estimated at $363,500 are proposed to be made. A Federal grant of $108,600 has been applied for. Bids were received in July 1961.

MATAWAN TOWNSHIP (RIVER GARDENS SECTION) SEWAGE TREATMENT PLANT

The Matawan township sewage treatment plant was built in and was designed to accommodate a flow of 0.25 mgd, providing contact aeration and chlorination. The treatment units consist of a sedimentation tank with contact aeration and post-chlorination facilities with a contact tank, sludge digestor and sludge beds. The effluent is discharged to Matawan Creek approximately 1/2 mile upstream from the confluence of Matawan Creek with Raritan Bay. The estimated populations served is approximately 280 families or about 1,000 persons with an average flow of approximately 0.13 mgd.

During a visit by the State Health Department representative on April 20, 1961 it was noted that the flow meter was out of order and the second stage aeration tank was not functioning properly. The operator is a part-time man putting in approximately two hours per day and the plant has suffered in the past from vandalism. It is our understanding that the Township plant is under orders of the State and that the matter has been referred to the New Jersey Attorney General's office. No information was available on the current performance of this plant nor was any information available on the sewer system as to whether there are any known by-passes.

MARLBORO TOWNSHIP (KNOLLCROFT SECTION) SEWAGE TREATMENT PLANT, N. J.

The Knollcroft treatment plant was completed early in 1960 to accommodate a design flow estimated at 0.2 mgd providing sedimentation plus chlorination. The treatment units consist of a bar rack, sedimentation tank and chlorination facilities including a contact chamber. The discharge is to an outfall line running 1,000' off the shore into Raritan Bay. The present population served is estimated at about 850 persons in the housing development called Knollcroft.

The Interstate Sanitation Commission made its first visit to this plant on June 12, 1961 and at that time found the coliform removal to be in violation of the Compact standard. This has been the only sampling of this plant and only one coliform series was tested. No information was available as to known by-passes.

SAYREVILLE (MORGAN SECTION) SEWAGE TREATMENT PLANT

The Morgan sewage treatment plant was built in 1951 to accommodate a design flow of 0.3 mgd providing sedimentation plus chlorination. The treatment units consist of a bar rack, mechanically-operated sedimentation tank, sludge digestors, chlorination facilities including a contact tank. The outfall line discharges into Raritan Bay approximately 600' offshore at the confluence of Cheesequake Creek and Raritan Bay. The estimated population served is approximately 2,000, and the average flow is estimated at approximately 0.1 mgd.

The inspections of the Interstate Sanitation Commission have shown that this plant has consistently met the coliform requirements of the Commission on all occasions. The plant has been sampled eight times in the last four years. During 1960 and 61 the plant was sampled once each year to determine Compact requirements on suspended solids. On both occasions the plant met the Compact requirements with removals of 78 and 86 per cent respectively in 1960 and 61. No information was available as to known by-passes.

SOUTH AMBOY SEWAGE TREATMENT PLANT

The South Amboy sewage treatment plant was built in 1940 to accommodate a design flow of 1.0 mgd providing sedimentation plus chlorination. The treatment units consist of a bar rack, two mechanically-equipped circular sedimentation basins, chlorination facilities including contact tank, sludge digester and glass-covered sludge beds. The outfall line discharges offshore into Raritan Bay. The estimated population served is 8,400 persons with an average flow of 0.7 mgd. The 1960 Census population for South Amboy was 8,422 persons.

Inspections by the Interstate Sanitation Commission since 1958 have shown that the South Amboy plant has met suspended solids removal requirements on 12 of the 13 occasions of a plant visit. The only failure to meet Compact requirements was on September 1, 1959, at which time the removal efficiency was 55%. The removals over the past 4 years have ranged from a low of 55% to a high of 87% during the visit of May 8, 1961. The South Amboy plant has met the coliform requirements of the Commission on every visit by the Commission staff during this past 4 years. The records of the Commission also noted that the South Amboy plant had by-passed for a period of time on or about June 30, 1958 while the clarifiers were undergoing repair. Again, in May of 1960, on or about May 16 to May 20, the plant by-passed to allow for the repair of the chlorine detention chamber. Again, on

May 8, 1961 the Commission noted that the plant was by-passing for a period from March 6, 1961 to April 17, 1961 while repairs to the pumps and piping as well as cleaning of the settling tanks were under way. The Interstate Sanitation Commission record indicate that the South Amboy sewer system is a separate system with 5 pumping stations, none having built-in by-passes.

SOMERVILLE (MELROSE SECTION) TREATMENT PLANT

The Melrose treatment plant was built in 1949 to accommodate a design flow of 0.1 mgd, providing sedimentation plus chlorination. The treatment units consist of a bar rack, mechanically-equipped sedimentation tank, chlorination facilities with a contact tank, sludge digester, and glass-covered sludge beds. The outfall discharges to the Raritan River upstream of the Garden State Parkway Bridge. The estimated population served is approximately a thousand persons with an average flow of approximately 0.05 mgd.

Inspections by the Interstate Sanitation Commission since 1958 have shown that the plant has failed to meet the suspended solids removal requirements of the Compact on 1 of the 2 occasions during which the plant was sampled for suspended solids. This was a removal of 33% recorded on April 4, 1960. On August 24, 1960 the removal was recorded at 68%. The plant has met the Commission standards for coliform removal on every occasion during the last 4 years - a total of 7 plant visits. No information was available as to known by-passes.

MIDDLESEX COUNTY SEWAGE TREATMENT PLANT

The Middlesex County sewage treatment plant was built in 1957 to accommodate a design flow of 52.0 mgd. The treatment consists of sedimentation, chemical treatment and chlorination. The treatment units are a bar rack, a grit chamber, chemical distribution chamber, clarriflocculators and chlorination facilities including a contact chamber with sludge storage and sludge digestion with disposal of sludge to the sea. The outfall line discharges to Raritan Bay approximately 7500' offshore through a series of 4 dispersion nozzles. The estimated population served by this plant is 289,410, served by trunk sewers. This includes 13 municipalities and 3 industries in the area. Average daily flow for 1960 was approximately 41 mgd.

Inspections by the Interstate Sanitation Commission staff since the beginning of operation, 1958, have shown the plant to fail Compact requirements on only 2 occasions during a total of 14 visits. The suspended solids removal has ranged from a low of 15% on August 23, 1960 to a high of 84% on June 30, 1958. The plant has met the ISC coliform requirements on every occasion during the last 14 visits. The records also indicate that for a period of 2 weeks, from February 17 to February 28, 1961, it was necessary to by-pass approximately 2 mgd for a total of 28 mgd at the Hayden Pumping Station because of a broken valve at this station.

Although the system is a combined system in that it takes both sewage and storm water flow, the plant is equipped to take the full storm discharge without necessity for by-passing of treatment facilities. By-passing of the treatment plant is possible from the grit chamber directly to the post-chlorination chamber. Records of the ISC indicate 3 pumping stations, 2 small ones with no known by-passes and the main pump station with 2 by-passes.

CAMP KILMER, NEW JERSEY

Camp Kilmer is located on the Raritan River near New Brunswick, N. J. The treatment facilities at this plant consist of high rate filtration, sludge digestion, and chlorination. The average flow is 1.0 mgd and the capacity of the plant is rated at 6.0 mgd. The discharge from this plant goes to the Raritan River.

Inspection by the State Health Department has shown the effluent to be satisfactory with the exception of coliform organisms. Discussions have been held with the Army Engineer office in charge by the Public Health Service Regional office to remedy this problem.

RARITAN ARSENAL, NEW JERSEY

Raritan Arsenal is located in Edison Township. The sewage treatment facility for this post provides primary settling, standard rate trickling filters, and sludge digestion and drying. A dry chlorinator is available but not in use. The capacity of the plant is 0.5 mgd., and the average flow is 0.25 mgd.

The State Health Department has found this plant to be satisfactory with the exception fo the lack of chlorination. Discussions have been held with the federal agency responsible for this plant to see that there is compliance with the State requirements.

WOODBRIDGE (KOSHER SECTION) SEWAGE TREATMENT PLANT

The Woodbridge-Keasby sewage treatment plant was built to accommodate a design flow of 1.35 mgd providing sedimentation, and chlorination. The treatment units consist of a bar rack, grit chamber, mechanically equipped sedimentation tanks, chlorination with a contact tank, sludge digesters and sludge drying beds. The outfall discharges Rimmey Creek and thence to to the Raritan River upstream from Perth Amboy. The estimated population served is 2000 persons.

No information is available as to the performance of this plant, at the time of the preparation of this report.

PERTH AMBOY SEWAGE TREATMENT PLANT

The Perth Amboy sewage treatment plant was built in 1934 to accommodate a design flow of 10.0 mgd providing sedimentation, chemical flocculation and chlorination. The treatment units consist of a bar rack, chemical flocculation chamber, mechanically-equipped settling tanks with magnetite filters, chlorination facilities including a contact tank, and vacuum filtration of the raw sludge after sludge conditioning. The outfall line discharges approximately 200' offshore of the treatment plant site into the Raritan River on the face of a public bathing beach of the city of Perth Amboy. The estimated population served is approximately 42,000 persons with an average flow of approximately 7.0 mgd.

Inspections by the Interstate Sanitation Commission staff since 1938 have shown that the plant has failed to meet compact requirements on suspended solids removal on 4 occasions during the 15 visits of the Commission. The suspended solids removals have ranged from a low of the negative removal recorded on March 28, 1961 to a high of 59% recorded on August 2, 1960. The plant has also failed to meet the Compact requirements on coliform removal on 3 occasions during the last 15 visits of the Commission staff.

Records of the Interstate Sanitation Commission show that the plant was by-passed for a period of one week from September 21 to

September 28, 1958 while the pumps were being repaired. During a visit of August 2, 1960 the Commission staff noted that bubbles were rising in the center portion of both clarifiers indicating a septic condition. It was also noted on this report that a State inspector had reported recommending in the beginning of July an extension of the outfall pipe. It noted that a lifeguard on the beach had said that a couple of samples had recently been taken at the beach by the State inspectors. During a visit of May 9, 1961 it was noted by the Commission staff that the filters had started spilling over through the emergency relief passes recently built into the filters. During a visit on April 21, 1961 by the State inspector it was noted that one filter was out of operation due to clogging by industrial waste from their local paper company. It was also noted that this filter had been out of operation since April 5. These filters are by-passed by a series of relief pipes inserted in the circumference of the filter to allow the liquid to escape through the pipe rather than up-flow through the filter as the plant was designed.

The sewer system in Perth Amboy is a combined system with 18 leaping weir devices. These by-pass devices are set to by-pass all flows over 9 million gallons per day. By-passing has occurred from time to time during periods of storm.

WOODBRIDGE (SEWERAGE SECTION) SEWAGE TREATMENT PLANT

The Woodbridge (Sewerage) sewage treatment plant was built in 1954 to accommodate a design flow of 10.0 mgd. The treatment consists of sedimentation. The treatment units include a grit chamber, bar screens, aerated flocculation tanks, mechanically-equipped settling tanks, mechanical filters, chlorination equipment including chlorine contact tanks and vacuum filtration for sludge. The outfall discharges to Arthur Kill. The estimated population served is 21,000 persons. The plant serves a portion of Woodbridge Township. The remainder of the Township is sewered to the Rahway Valley Sewage Treatment Works or to the Woodbridge Township Sewage Treatment Plant at Keasby, New Jersey. Average flow for the plant is estimated at 2.2 mgd.

Inspections by the Interstate Sanitation Commission staff since 1958 have shown the plant to meet the Compact requirements for suspended solids removal. This plant is in the ISC Class "B" waters. Suspended solids removal of only 10% is required and no coliform removal is required. No chlorination practiced during 1960 according to the ISC records. Woodbridge Township has a separate system with 6 pumping stations. None of the pumping stations have built-in by-passes.

time to time during periods of storm.

THE CARTERET SEWAGE TREATMENT PLANT

The Carteret sewage treatment plant was built in 1953 to accommodate a design flow of 3.0 mgd. The treatment consists of sedimentation. The treatment units include a bar rack, grit chambers, chemical flocculation tanks, mechanically-equipped settling tanks sand filters and chlorination facilities, including a chlorine contact tank with vacuum filtration after sludge conditioning. The outfall discharges to the Arthur Kill. The estimated population served by this plant is 13,000 persons. The 1960 Census for Carteret shows a population of 14,603. The average flow is 2.4 mgd.

Inspections by the Interstate Sanitation Commission since 1958 have shown the plant has failed to meet Compact requirements for suspended solids removal on only 1 occasion in a total of 13 visits. The plant discharges to Class "B" waters of the Interstate Sanitation Commission. The standards for these waters are 10% removal of suspended solids and no chlorination is required. The sewer system is a combined system with 3 pumping stations. The 3 stations do not have built-in by-passes. The system, however, has 7 regulating chambers, 6 with outfalls to the Arthur Kill and the 7th with an outfall to the Rahway River. All regulators are controlled by float valves.

RAHWAY VALLEY SEWAGE TREATMENT PLANT

Rahway Valley sewage treatment plant was constructed in 1928 to accommodate a design flow of 16.7 mgd. The treatment consists of sedimentation. Treatment units include bar racks, grit chamber, mechanically-equipped sedimentation basin, sludge digestion with vacuum filtration and glass-covered sludge beds. The outfall of this treatment plant was recently extended to discharge to the Arthur Kill. The treatment plant serves an estimated population of 170,000 persons.

Inspections by the Interstate Sanitation Commission since the plant came within their jurisdiction in 1959 has shown that the plant has met Compact requirements for suspended solids removal on each of the 6 visits made by the Commission staff. The plant is located in Class "B" waters and, therefore, no chlorination is practiced except for odor control. The sludge is discharged to the Linden-Roselle plant for disposal by barging to sea. No information was available as to known by-passes.

LINDEN-ROSELLE SEWAGE TREATMENT PLANT

The Linden-Roselle sewage treatment plant was built in 1952 to accommodate a design flow of 12.5 mgd. Treatment consists of sedimentation. Treatment units consists of bar screens, grit chamber, mechanically-equipped settling tanks and sludge storage tanks with sludge disposal by barging to sea. The outfall line discharges to Arthur Kill. The estimated population served by this plant is 120,000. The average flow is 12.2 mgd. The plant influent includes a large tributary loading of industrial waste.

Inspections by the Interstate Sanitation Commission since 1958 have shown this plant to meet the Compact requirements for suspended solids removal on each of the 12 visits by the Commission staff. The plant is located in Class "B" waters and no chlorination is required. The Commission staff, however, has noted that this plant has by-passed on numerous occasions in the past. A record of these by-passes is as follows:

April 17, 1958	- partial by-passing during rains
June 15, 1959	- by-passing
June 23, 24, 25, 1960	- by-passing due to power failure
September 12, 1960	- by-passing due to hurricane for 8 hrs.
December 21, 1960	- by-passing for 16 hrs.

January 1, 1961 - By-passed for 24 hrs due to high flow over 30 mgd.

Linden-Roselle is, for the most part, a separate system with 2 pump stations and one regulator. Both pump stations contain emergency by-pass provisions. A regulator located on Morse's Mill Road contain emergency by-pass provisions. A regulator located on Morse's Mill Road contains a 48" outfall to Morse's Creek as of 1959.

ELIZABETH JOINT MEETING SEWAGE TREATMENT PLANT

The Elizabeth Joint meeting treatment plant was built in 1937 to accommodate a design flow of 100 mgd. Treatment consists of sedimentation. Treatment units include screens, grit chamber, mechanically-equipped sedimentation, and sludge storage with sludge disposed of by barging to sea. The outfall discharges to the Arthur Kill. The estimated population served is approximately 475,000 persons. The average flow is approximately 52 mgd.

Inspections by the Interstate Sanitation Commission since 1958 have shown the plant to meet the Compact requirements for suspended solids removal on each of the 11 visits by the Commission staff. The plant is located in Class "B" waters, no chlorination is required. The Joint meeting plant serves 12 communities. With the exception of Elizabeth, the communities have separate systems with gravity flow. Elizabeth has 1 pump station and 8 regulating chambers. In case of surcharging the pump station backs the flow up the main and out through the regulators which discharge to Arthur Kill at various locations.

WILLOWBROOK STATE SCHOOL, STATEN ISLAND

Willowbrook State School is served by a primary treatment plant built in 1941. The plant was designed to accommodate a flow of 0.6 mgd. Treatment consists of sedimentation. Discharge is through an outfall to Fresh Kills, at the conjunction of Fresh Kill with the Arthur Kill. The population served is estimated at 4,000 persons. Average flow is estimated at 0.6 mgd.

The plant has met the Compact requirements for suspended solids removal on all occasions. Since the plant is located in Class "B" waters chlorination is not required.

TOTTENVILLE SECTION OF STATEN ISLAND

Tottenville Section of Staten Island, comprising a drainage area of approximately 2600 acres, drains to both Arthur Kill and Raritan Bay. In 1960 the estimated population for this area was 8,250 persons. Considering the number of sewers in the drainage area New York City Public Works Department estimates that at least half of this group discharge their waste to individual sub-surface disposal systems. The waste from the remainder, or about 4000 persons, drains directly to the Arthur Kill and Raritan Bay through sewers without benefit of sewage treatment. This raw sewage reaches Raritan Bay and Arthur Kill through several different sewer outlets.

MT. LORETTO HOME, STATEN ISLAND, NY

Mt. Loretto Home has 2 sewage treatment facilities, built around 1937. These facilities were designed to accommodate a flow of 0.1 mgd. Both of these facilities consist of septic tanks. Discharge is to Raritan Bay. The system serves a population of approximately 1000 children and 200 adults. There are 4 separate septic tanks, each with a capacity of 22,500 gallons. HTH solution is applied to the effluent of 3 of these tanks. The 4th tank is not chlorinated. Average flow is estimated at .09 mgd.

Inspections by the Interstate Sanitation Commission indicate that the plant has failed to meet Compact requirements for coliform removals on every occasion during the 6 visits made by the Commission staff.

S. S. WHITE DENTAL COMPANY, STATEN ISLAND

The S. S. White Dental Company is served by a chlorination contact tank. Population served is approximately 700 persons. Discharge is to Raritan Bay. HTH is used for chlorination. No information is available as to performance of this plant since this plant has not been sampled by the Interstate Sanitation Commission.

ST. JOSEPH'S HOME

St. Joseph's Home has 5 septic tanks and serves approximately 40 persons in the winter and 200 during the summer months. The plant has failed to meet the Commission coliform requirements in the one visit recorded by the Commission staff during the past 4 years.

MARIST NOVIATIATE, STATEN ISLAND

The home of the Marist Novitiate on Bayview Avenue in Staten Island is served by two small septic tanks which discharges to Lemon Creek a small tributary to Raritan B ay. The plant serves an estimated 35 persons in the home. No other information is available.

RICHMOND MEMORIAL HOSPITAL

Richmond Memorial Hospital is served by a septic tank built in 1936 with a capacity of 10,000 gallons. There is, in addition, a 500 gallon baffled contact tank. HTH is added daily to the chlorine contact tank. The hospital has 160 beds and approximately 100 workers. In addition, 6 to 8 houses are also tied into these systems to give a population serve of approximately 300.

Inspections by the Interstate Sanitation Commission have indicated that this plant has failed to meet Compact requirements on each of the 5 visits made by the Commission staff.

OAKWOOD BEACH SEWAGE TREATMENT PLANT, NEW YORK CITY

The Oakwood Beach sewage treatment plant was built in 1956 to accommodate a design flow of 15.0 mgd. Treatment consist of high rate activity sludge and chlorination. Treatment units are a bar rack, grit chamber, aeration tanks, mechanically-equipped secondary tanks, chlorination, sludge thickening, sludge digestion with sludge disposal by barging to sea. The estimated population served by this plant is 35,000 persons. The average flow is approximately 10 mgd.

Inspections by the Interstate Sanitation Commission since 1958 have shown that the plant has failed to meet effluent standards for suspended solids removal on 2 occasions during the 11 visits to this plant. Similarly, on 2 occasions the plant has failed to meet the coliform removal requirements of the Commission on a total of 15 visits to the plant. Suspended solids removals have ranged from a low of 34% on November 19, 1958 to a high of 76% - record on July 15, 1960. The system is reported to be a separate sewer.

There are additional sources of pollution in the Rarity Bay area which have not been evaluated for this report. Because of the lack of information available at this time it has been impossible to include a determination of the amount of pollution entering the Raritan Bay - Lower Bay complex from the Upper Harbor area through the Narrows. Also it has been impossible to determine the quantity of industrial wastes entering the Arthur Kill area from the large industrial complex on the shoreline of the Kill. The Interstate Sanitation Commission estimates that floating from these industrial plants is 100,000 lbs. of BOD per day. This estimate was for the total of all industries to the Kill, and an individual breakdown was not available. The industries contributing to this pollutional load are listed below:

INDUSTRIES ALONG ARTHUR KILL

NEW JERSEY

1. Phelps Dodge Copper Product Corporation
2. Archer Daniels Midland Company
3. Cities Service Oil Company
4. National Lead Company
5. Koppers Company, Inc., Wood Preserving Division
6. Vulcan Detinning Co., Division of Vulcan Materials Co.
7. Westvaco Mineral Products Division of FMC
8. General American Tank Storage Terminals
9. American Cyanamid
10. General Aniline & Film Corp.
11. E. I. duPont de Nemours & Company
12. Esso Bayway Refinery
13. California Oil Company

NEW YORK

1. Nassau Smelting and Refining Co., Inc.
2. Socony Mobil Oil Co., Inc.

Also, because of the network of combined sewers in the communities facing the Bay and the Kill the problem of storm water overflow has not been evaluated. There is not sufficient data available on the frequency and the magnitude of these overflows to determine the extent of influence of these overflows upon the water quality in Raritan Bay. It will be noted in the summary paragraphs on each of the treatment plants that notation was made where information is available on the sewerage system, as to the extent of storm water regulators or overflow arrangements.

Another problem which has not been thoroughly assessed is the contamination contributed to this area by the large number of commercial vessels which traverse the area - the busiest harbor in the world. The Table, No. ____, below gives an indication of the volume and tonnage of commercial shipping which pass through the Raritan - Lower Bay and tributary complex. Related to this is the problem of waste discharges from small vessels of the pleasure craft category. It is known that there are approximately 45 marinas in the area with over 2,500 berths for use by pleasure craft.

TABLE ___

1959 STUDY AREA DATA

Area	Tons Handled	Vessel Trips	Passengers
New York and New Jersey Channels	80,805,095	149,346	1,750,153
Thru Traffic	25,846,556		
Raritan River	7,163,897	30,492	356,123
Thru Traffic	82,365		
Shoal Harbor and Compton Creek, New Jersey	55,068	2,428	
Cheesequake Creek, NJ		14,400	25,250
Great Kills Harbor, SI		116,960	123,136
Shrewsbury River, NJ		22,320	188,480
Sandy Hook Bay, NJ		6,346	

WATER QUALITY

Introduction

Raritan Bay receives fresh water flow from two major river basins and, in addition, receives saltwater flow from the Atlantic Ocean. Accordingly, not only the salinity of the Bay, but also the sanitary water quality characteristics are influenced by these sources of fresh and salt water which mix and influence the water quality of Raritan Bay. In each instance evaluation of the numerous factors influencing the quality of these major sources is an extremely complex problem. Integration of the three is of even greater complexity. In spite of this, however, there are several conclusions with regard to water quality in Raritan Bay which can be drawn once the hydrography of the area and the major quality characteristics of the tributary sources of flow have been considered.

Pertinent Physical Characteristics

Generally, the Bay consists of shallow areas with considerable shoaling, except for the main channels which average 35 foot in depth. The largest of the channels extends from the Narrows to Sandy Hook and, in effect, forms the easternmost boundary of Raritan-Lower Bay complex.

The second major channel, the New York-New Jersey Ship Channel, extends from the mouth of the Raritan River, and runs eastward thru Raritan Bay to the channel formed by the extension of the Hudson River. The New York-New Jersey channel follows the shore of Staten Island very closely for approximately one mile, and then swings sharply away from the shore in the eastern part of Raritan Bay. Thus, the eastern and

western sections of Staten Island have essentially different physical characteristics. The western section has a comparatively deep offshore channel, while the eastern section has a comperatively shallow offshore area. As a consequence, waters leaving the western end of Raritan Bay tend to hug the western Staten Island shore but subsequently by-pass the eastern shore of Staten Island as they follow the ship channel across the state line towards the Atlantic Ocean.

Tidal Influences

Raritan Bay is a true tidal bay in the sense that circular patterns occur in many areas rather than a simple reversals of current which is typical of tidal estuaries. For instance, reference to the tidal current charts for the area indicates that in the middle of Raritan Bay the flood current does not proceed northerly throughout the flood phase of the tidal cycle, but rather first flows in a westerly directly, then swings to a northerly directly, and then to a northeasterly direction.

In an effort to more clearly define and demonstrate the combined effects of the fresh water flow, the ebb and flow of the tide, and the location and direction of the various channels, several agencies have performed studies including model tracer and float studies.

Hydrography

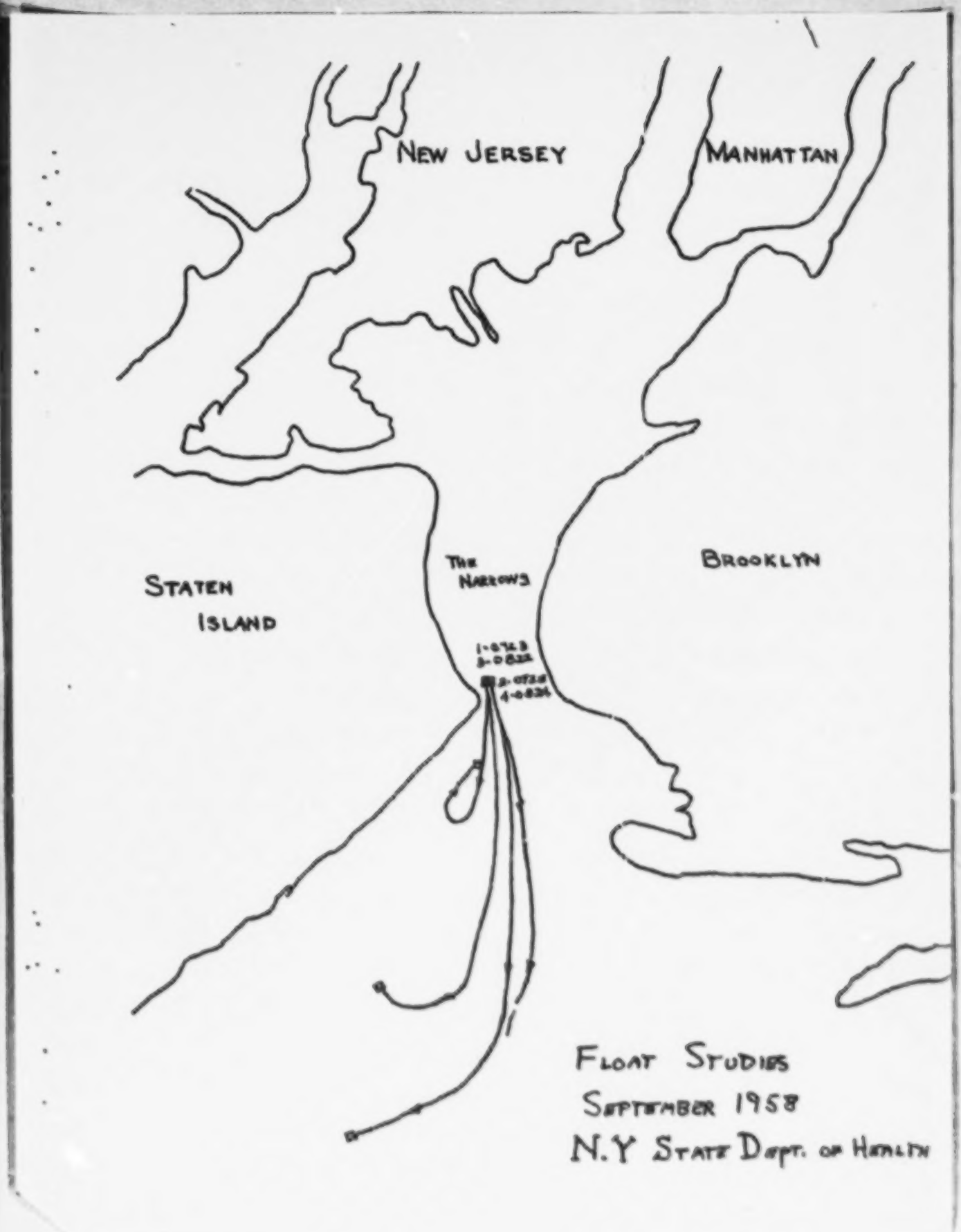
Mixing and dispersion characteristics were studied in the New York Harbor model of the U.S. Army Corps of Engineers, located at

Vicksburg, Mississippi. Tracers were introduced into the model at six locations in the New York area. Of particular interest were studies to determine mixing and dispersion when tracers were added at the confluence of the Rahway River, and the Arthur Kill, a point just north of the Narrows, and a point approximately 15,000 feet southeast of the Narrows. In each instance, the tracer was found throughout the rest of the harbor at various concentrations after 15 tidal cycles. For instance, the injection of the tracer at the confluence of the Rahway River and the Arthur Kill resulted in the tracer subsequently being found at stations both up and down the Arthur Kill, through Raritan, Lower and Sandy Hook Bays, Kill Van Kull, and Newark and Upper Bays. When injected at a point 15,000 feet southeast of the Narrows, the tracer was later found in all of the previously-mentioned waterways. The tracer injected north of the Narrows was found throughout the Lower Bay and in and around Sandy Hook, as well as along the Kill Van Kull and the northern end of the Arthur Kill. Thus, introduction of a material at any point into the waters of this area will subsequently, result in the appearance of the tracer at most other locations in the harbor.

Prototype float stdies were performed by several agencies. While floats do not necessarily plot the actual path of pollutants, they do give evidence of the existence of tidal patterns at the time and depth covered by the observations which influence the dispersion of pollutants.

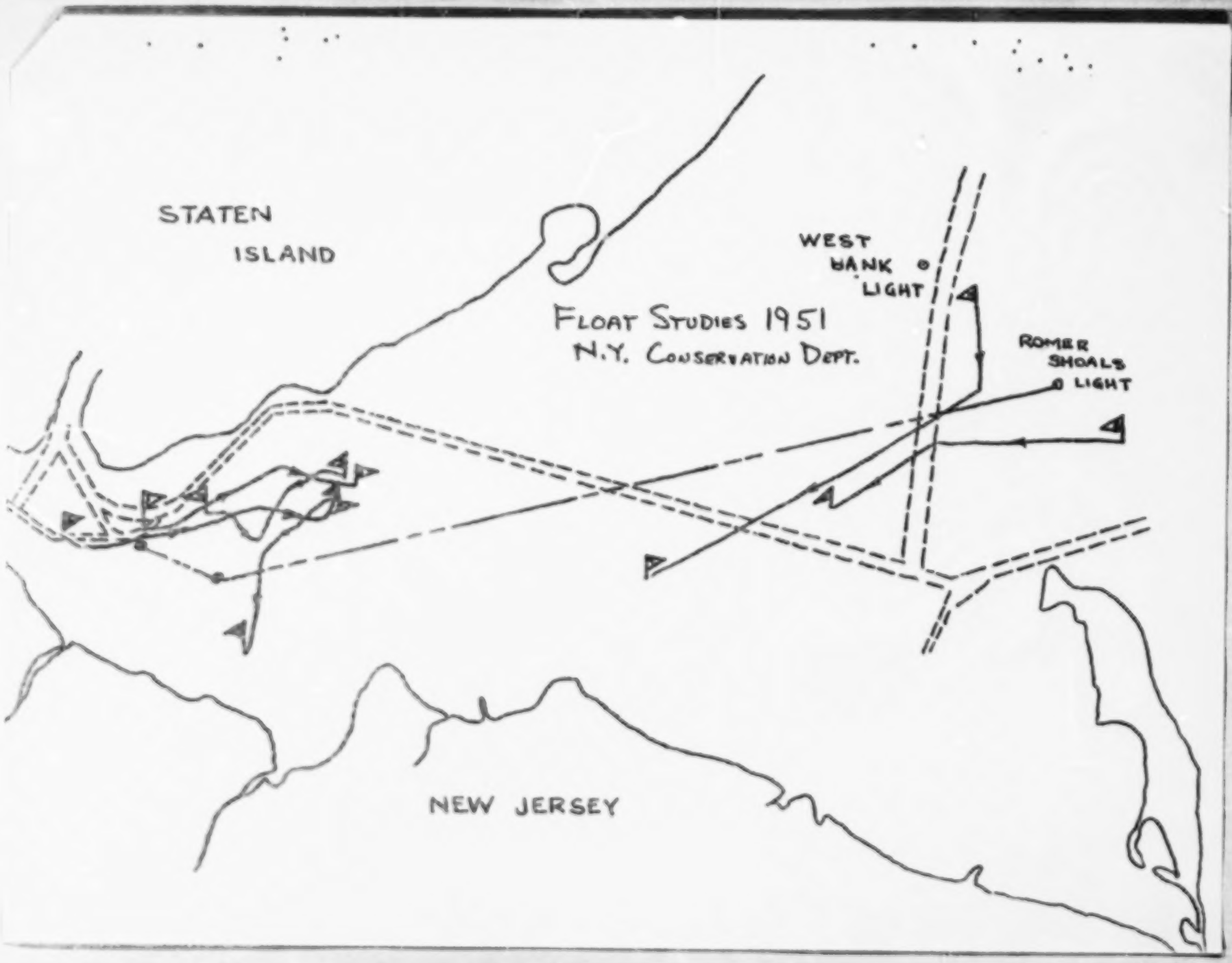
One investigation indicated that pollutants from the Owls Head and Passaic Valley Plants can reach the Staten Island beaches in one tidal cycle. Figures ___ and ____ show the tidal patterns when floats were released in pairs 400 ft. apart at the west side of the

FLOAT STUDIES
AUGUST 1958
N.Y. STATE DEPT. OF HEALTH


NEW JERSEY
MANHATTAN
THE NARROWS
BROOKLYN
STATEN ISLAND
FLOAT STUDIES
SEPTEMBER 1958
N.Y STATE DEPT. OF HEALTH

Narrows. Figure ___ indicates that three pairs of floats released around ebb current passed through the Narrows, turned in a clockwise manner and swirled back towards the beaches along the Staten Island shore. One of these floats went aground at South Beach within 5½ hours after being released. Figure ___ shows the path of two pairs of floats released under similar current conditions. The same general clockwise motion is evident although three floats carried further out into Lower Bay, and passed in and around West Bank Light, which is approximately 2 nautical miles north of the New York - New Jersey state line.

Studies in the vicinity of West Bank Light were performed by Shell to determine the direction of tidal transport of mixed Upper Bay and Atlantic Ocean waters during flood tide (Figure ___). One float was released between West Bank Light and Romer Shoals Light, and the other was released at a point just southeast of Romer Shoals Light (New York - New Jersey State boundary). The first float followed a southeasterly course across the state line to Flynns Knoll, then turned and moved southwesterly for a distance of 4½ nautical miles towards the Jersey shore. All forward movement ceased at the beginning of the shoal area 1.4 miles due northeast of Point Comfort, New Jersey. Similarly, the second float also followed a westerly course for 2.2 nautical miles to a midpoint in Chapel Hill Channel, and then continued in a southwesterly direction for 1.5 nautical miles for a total distance of 3.6 miles in 5½ hours. Thus, these float studies appear to confirm the model study and indicate that waters leaving the Narrows can be transported across the State line, deep into Lower Bay.


STATEN
ISLAND
WEST
BANK
LIGHT
FLOAT STUDIES 1951
N.Y. CONSERVATION DEPT.
ROMER
SHOALS
LIGHT
NEW JERSEY

Udell also conducted a study in the western portion of Raritan Bay to determine the ebb tide drift of waters from Raritan Bay and the Arthur Kill. The floats were released at Great Beds Light at the beginning of each tide. All of the floats followed the same general course along the channel to Round Shoal with a tidal drift of 3 miles. At the beginning of flood tide two other floats were started from the locations where the ebb tide floats had stopped. One float traveled west while the other traveled westerly and southwesterly (Figure ___). He concluded that, "This float study indicated that fresh water from the Raritan River flows seaward and along the channel area to approximately Buoy #13 (the point where the channel turns north) and then continues south of the main channel. It also indicated that very little fresh water entering the embayment from the Raritan River returns to the river on the flood tide". It is believed that Udell's recent unpublished studies in the same area confirm his previous observations.

Thus, the previously quoted studies show that the waters of Raritan Bay are interstate in nature.

Water Quality Considerations

Coliform density and dissolved oxygen data are employed in this section to indicate the water quality. This is not meant to imply that they are either the most important or the only criteria of significance. However, since dissolved oxygen reflects the influence of organic pollutants and coliform densities are indicative of waterborne disease potential, they are employed in this presentation to establish the

general water quality characteristics of the area.

Influence of Tributary Waterways

Tidal mixing and dispersion have a distinct influence upon the water quality of Raritan and Lower Bays. On the ebb, waters from each of the various bays, estuaries and straits flow out into Raritan and Lower Bays and become intermingled. Subsequently, on the flood tide a portion of these same materials may return. Moreover, as shown by tracer studies, mixing occurs throughout the area and indicates that pollutants from one waterway may be introduced into, not only adjacent areas, but also into waterways at considerable distances from the point of origin. Thus, it is appropriate to first consider the quality of water in the Arthur Kill, at the mouth of the Raritan River, and at the Narrows prior to considering the resultant quality of Raritan and Lower Bays.

Quality of Tributary Waterways

Bacteriological data of the New York City Department of Public Works are presented in Figure ___ to indicate the variation in coliform content along the Arthur Kill, which is an interstate stream. The geometric mean at stations K-3, K-4 and K-5 for the years 1958 through 1961 demonstrate that the Arthur Kill north of Outerbridge is generally grossly polluted. The minimum yearly MPN content at stations K-3 and K-4 was 13,500 per 100 ml., while the majority of the yearly values were in excess of 60,000 per ml. with two yearly values at station K-3 at 110,000

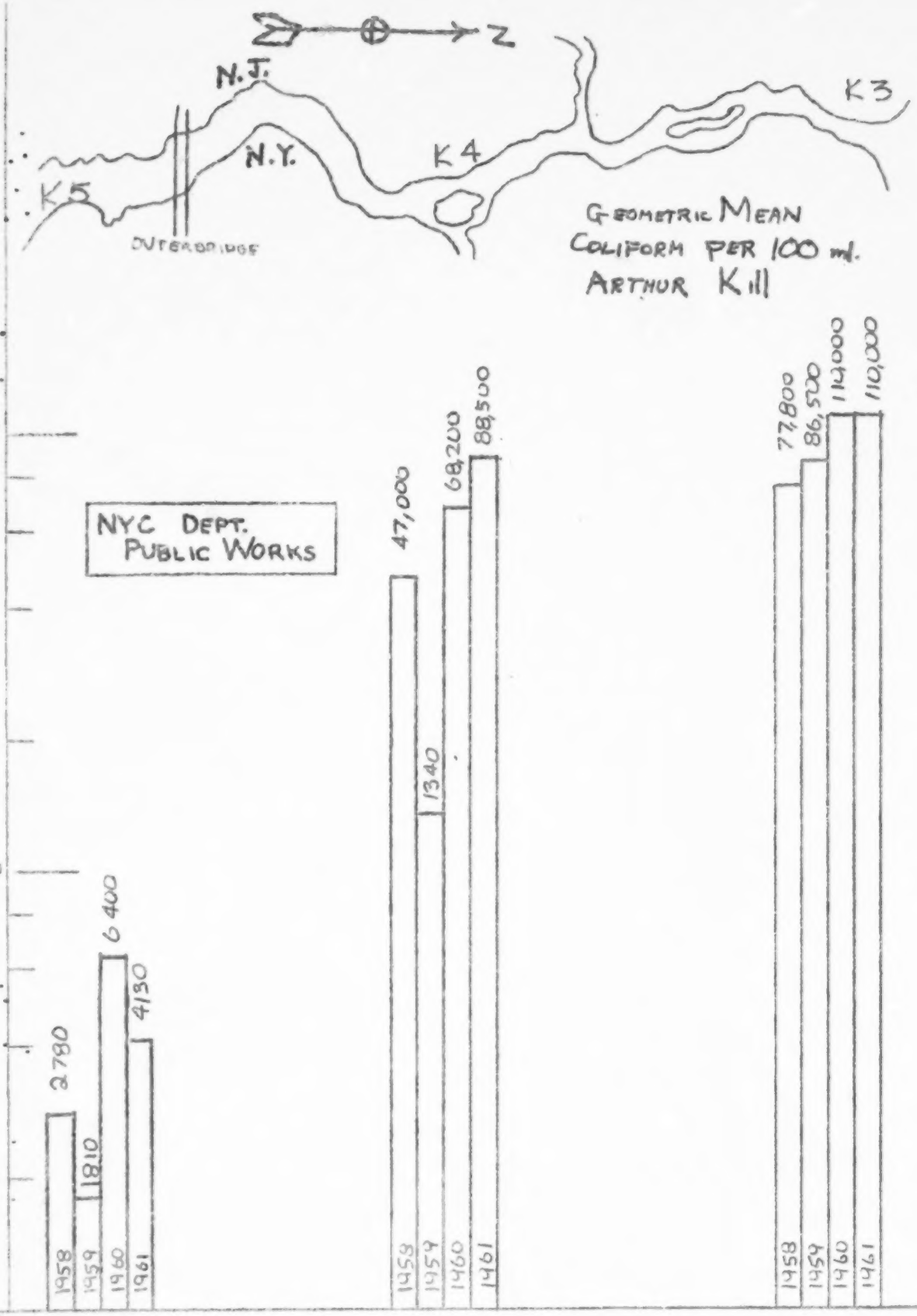
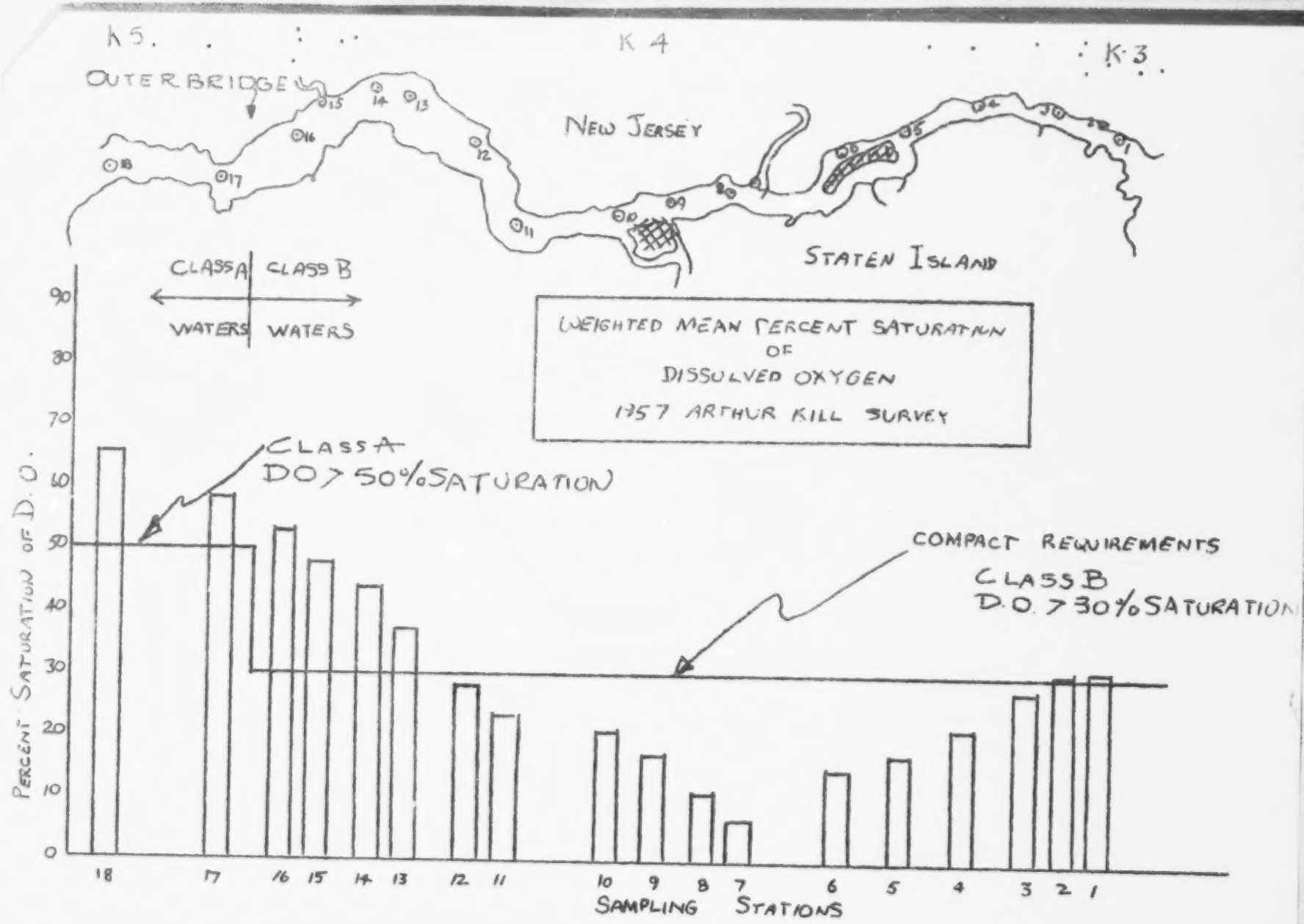

N
N.J.
N.Y.
K5
K4
K3
OUTERBRIDGE
GEOMETRIC MEAN
COLIFORM PER 100 ml.
ARTHUR KILL
NYC DEPT.
PUBLIC WORKS
2780
1810
6400
4130
47,000
1340
68,200
88,500
77,800
86,500
110,000
110,000
1958
1959
1960
1961
1958
1959
1960
1961
1958
1959
1960
1961

Fig 0

per 100 ml. At station K-5 located at the confluence of the Arthur Kill and Raritan Bay, and subject to dilution through tidal exchange, the coliform content was appreciably less. The four yearly geometric mean values at station K-5 for 1958 through 1961 were 2,800; 1,800; 6,400; and 4,100 per 100 ml., respectively.

The dissolved oxygen data for the Arthur Kill, presented in Figure ___, were generally low north of Outerbridge and high south of Outerbridge. The dissolved oxygen profile indicates the effect of municipal and industrial discharges upon the oxygen resources of the Arthur Kill. Furthermore, it should be noted that for 6.4 miles above Outerbridge the 1957 survey of the Interstate Sanitation Commission showed that the dissolved oxygen content was less than 30 per cent of saturation and, therefore, did not meet the Compact requirements for Class "B" waters.

Rand and Segesser have reported on the improvement of water quality of Raritan River following the completion of the Middlesex County Sewerage Authority sewage treatment plant in 1957. During 1958, they reported that the percent dissolved oxygen saturation at Victory Bridge, one-half mile above Raritan Bay, was 62% in comparison to 2% during 1957. However, with respect to the MPN of coliform bacteria, the authors state that "No effort was made to consider the quality of either the Raritan River or its tributaries from the standpoint of coliform densities. It was found that the occurrence of heavy rainfall and subsequent surface runoff resulted in the presence of abnormally large numbers of coliform organisms in the various streams. For this reason the sanitary significance of the presence of these organisms is somewhat questionable in this instance".



FROM ISC ANNUAL REPORT 1958

They do present coliform data for Raritan Bay at the junction of the Raritan River and the Arthur Kill. The geometric means for 1958 and 1959 were 1450 and 1800 MPN per 100ml. respectively with 10 percent of the values in excess of 10,000 MPN per 100 ml.

Just as the quality in western Raritan Bay is influenced by the intermingling of waters from Raritan River and Arthur Kill, eastern Raritan Bay and Lower Bay water quality is affected by the waters which leave the Narrows. The water quality at the Narrows results from the continuous mixing of ocean waters and the wastes, treated and untreated, from over ten million people tributary to the Upper Harbor area.

The 1959 report of the Interstate Sanitation Commission indicates the weighted mean percent saturation of dissolved oxygen as 52 percent at the Narrows. Coliform data of the NYC Department of Public Works collected over a tidal cycle during each of the last three years are summarized in Table ___, and indicate bacterial quality of the waters which pass through the Narrows. Data are presented to indicate the most probable number of coliform bacteria per 100 ml. for cross section data.

Consideration of Table ___ indicates that surface quality is generally poorer than at the bottom. Furthermore, attention is directed to the fact that 12 of 18 yearly geometric mean values were in excess of 20,000 per 100 ml. Thus, it can be stated that the waters flowing south through the Narrows are generally at 50 percent dissolved oxygen saturation and have a coliform content in excess of 20,000 per 100 ml.

TABLE ____

HARBORS SAMPLING STATIONS

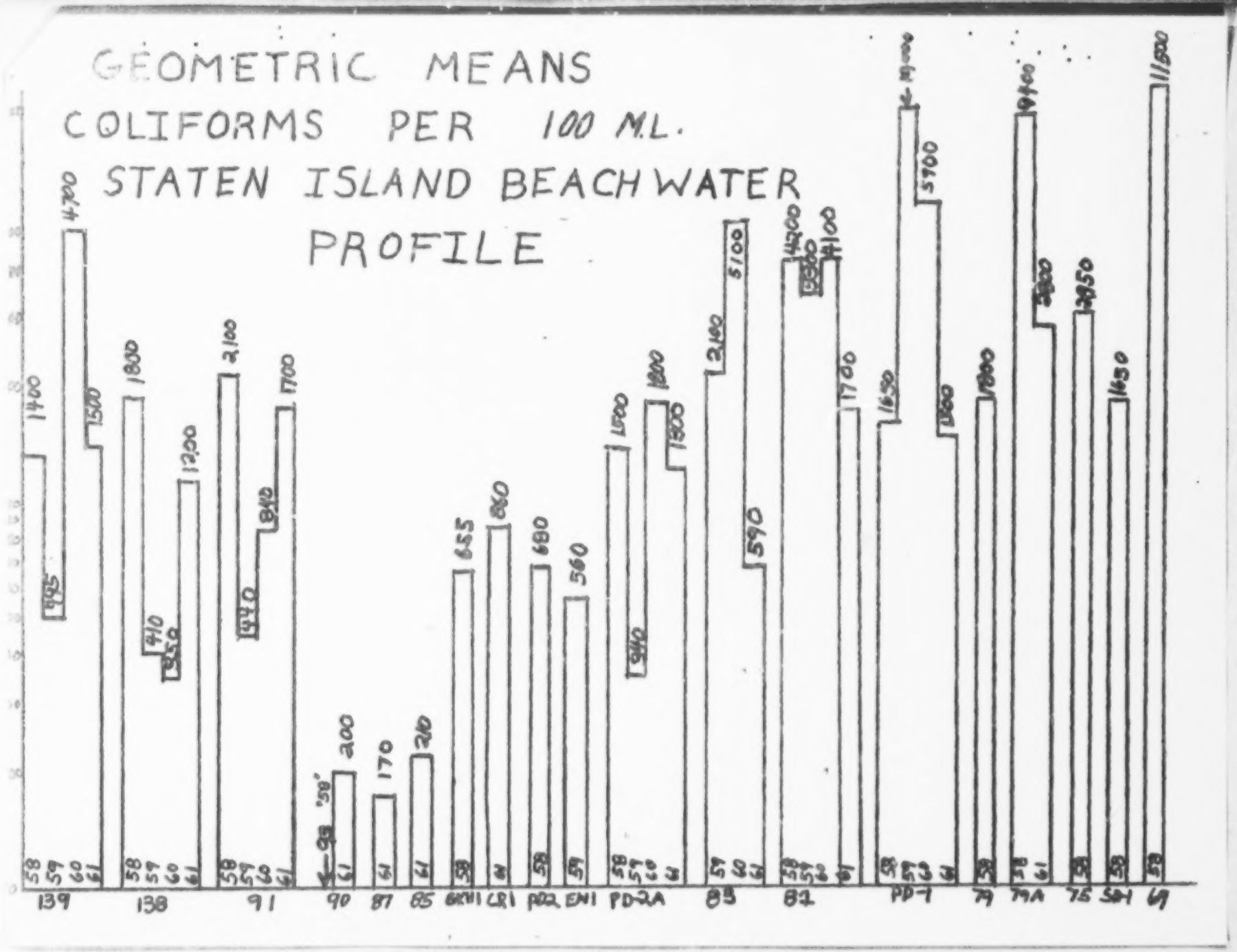
GEOMETRIC MEANS FOR TIDAL CYCLE DATA

Year		H8 West	H8	H8 East
1959	Top	15,000	14,000	26,000
	Bottom	12,000	11,000	5,300
1960	Top	53,000	33,000	15,000
	Bottom	34,000	64,000	32,000
1961	Top	34,000	30,000	37,000
	Bottom	27,000	24,000	34,000

Water Quality in Raritan and Lower Bays

The effect of the major sources of pollution on the eastern and western ends of Staten Island are shown by consideration of the beach sample data collected by the NYC Health Department between 1958 and 1961. These data are presented in Figure ___. It will be noted that at the western end of Staten Island, in the 2½-mile stretch between Tottenville and Sequine Point where the New York-New Jersey Ship Channel approaches and then hugs the shore, that 7 of the 12 geometric means exceed 1000 per 100 ml. The water quality between station 90 and station B81, a 4-mile stretch between Sequine Point and the eastern end of Great Kills Park, was consistently below a geometric mean of 1000 per 100 ml. High yearly values up to 22,000 MPN per 100 ml. occurred within the 4-mile stretch between Great Kills Park and the Narrows, which was previously shown to be under the influence of waters passing through the Narrows.

Two profiles to indicate variations in the most probable number of coliform bacteria along the New York-New Jersey Ship Channel and the New York-New Jersey state line for the length of Raritan and Lower Bays are presented as Figures ___ and _____, respectively. It will be noted that the patterns indicated in these figures are similar to that shown by the previously described Staten Island Beach Profile data. The MPN per 100 ml. is relatively high on both the eastern and the western ends of all 3 profiles and relatively low in the middle sections. For instance, as indicated in Figures ___ and ___, the coliform content at station K-5 at the mouth of the Arthur Kill is well in excess of 1,000


GEOMETRIC MEANS
COLIFORMS PER 100 M.L.
STATEN ISLAND BEACHWATER
PROFILE
139
138
91
90
87
85
BKN1
LR1
PD2
EN1
PD-2A
83
82
PD-1
79
79A
75
SR1
69

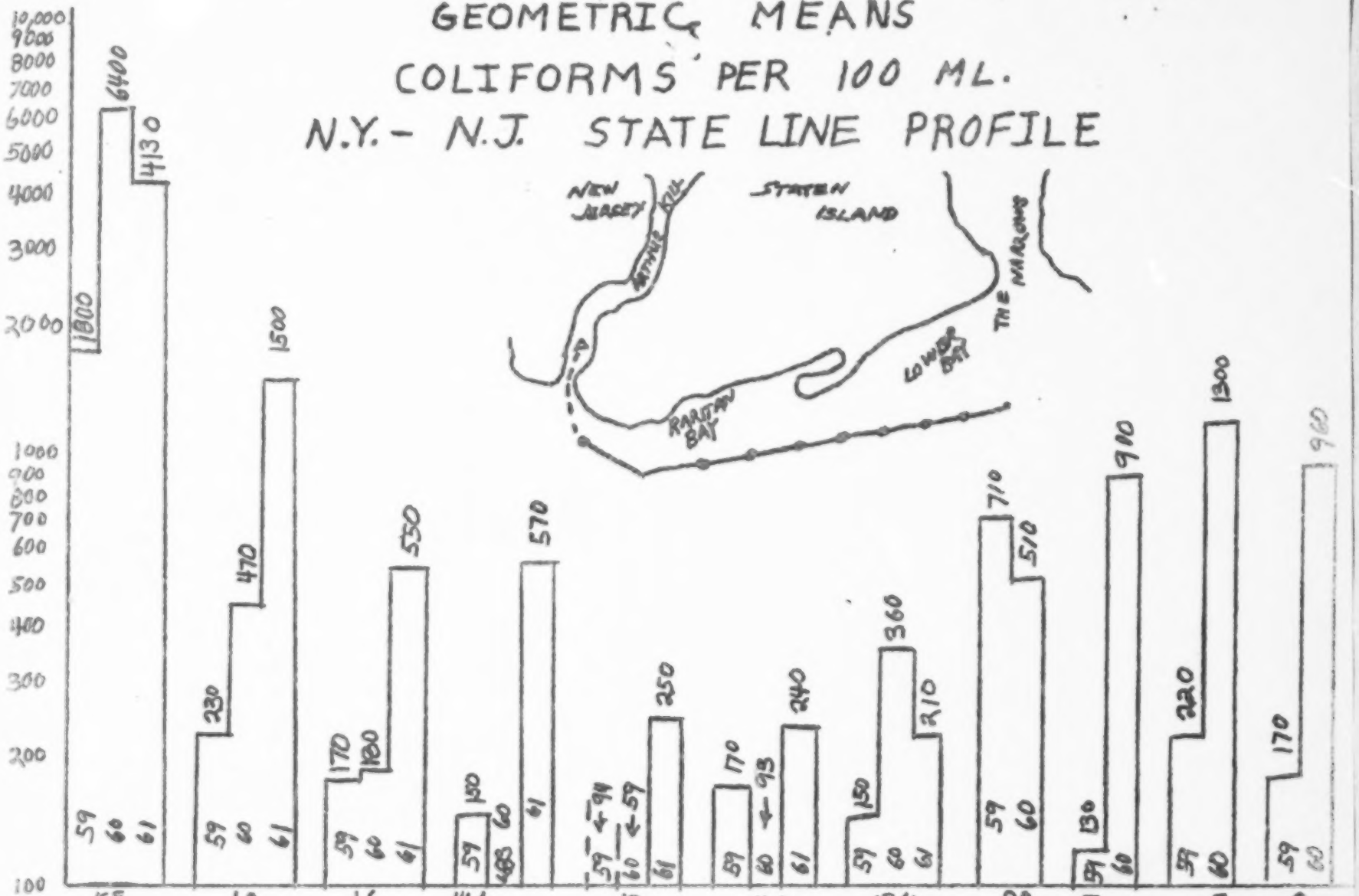
Profile Along New York New Jersey Channel

Geometric Mean Coliform /100 ml.

STATE LINE

K-5	1961	4130
K-5	1960	6400
K-5	1959	1810
K-5	1958	2780
28	1958	2660
28	1959	NO INFO.
28	1960	4600
26	1958	4470
26	1959	NO INFO.
26	1960	2400
34	1958	820
34	1959	NO INFO.
34	1960	1700
34	1961	340
36-A	1958	130
36-A	1959	NO INFO.
36-A	1960	330
36-A	1961	160
38	1958	82
38	1959	NO INFO.
38	1960	330
38	1961	160
39	1960	160
39	1960	160
52	1960	190
13/10	1959	150
13/10	1960	360
13/10	1961	210
33A	1959	300
33A	1960	430
47	1959	~~740~~ 480
47	1960	~~600~~ 580
71	1959	790
71	1960	600
78	1959	
78	1960	

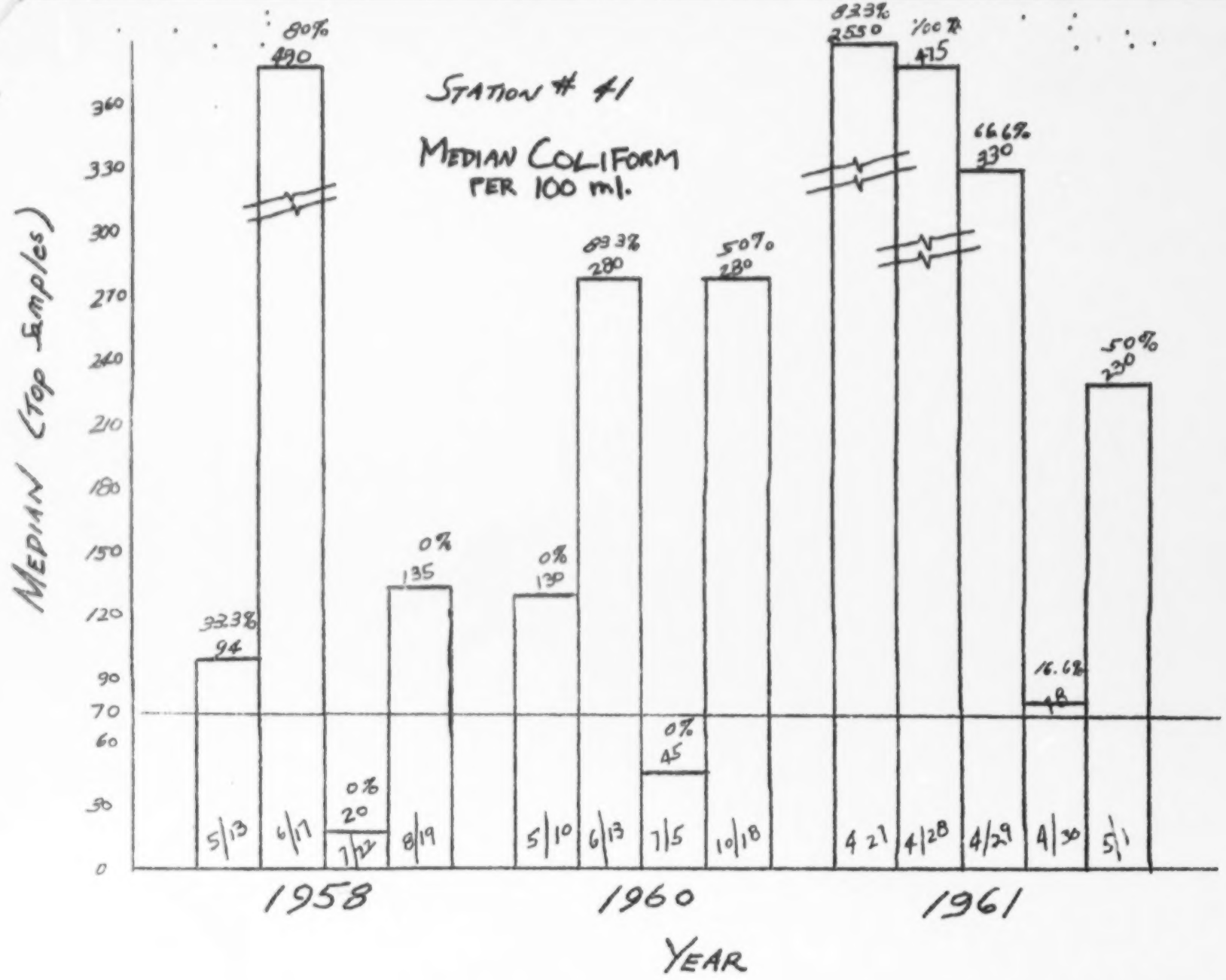
GEOMETRIC MEANS
COLIFORMS PER 100 ML.
N.Y. - N.J. STATE LINE PROFILE

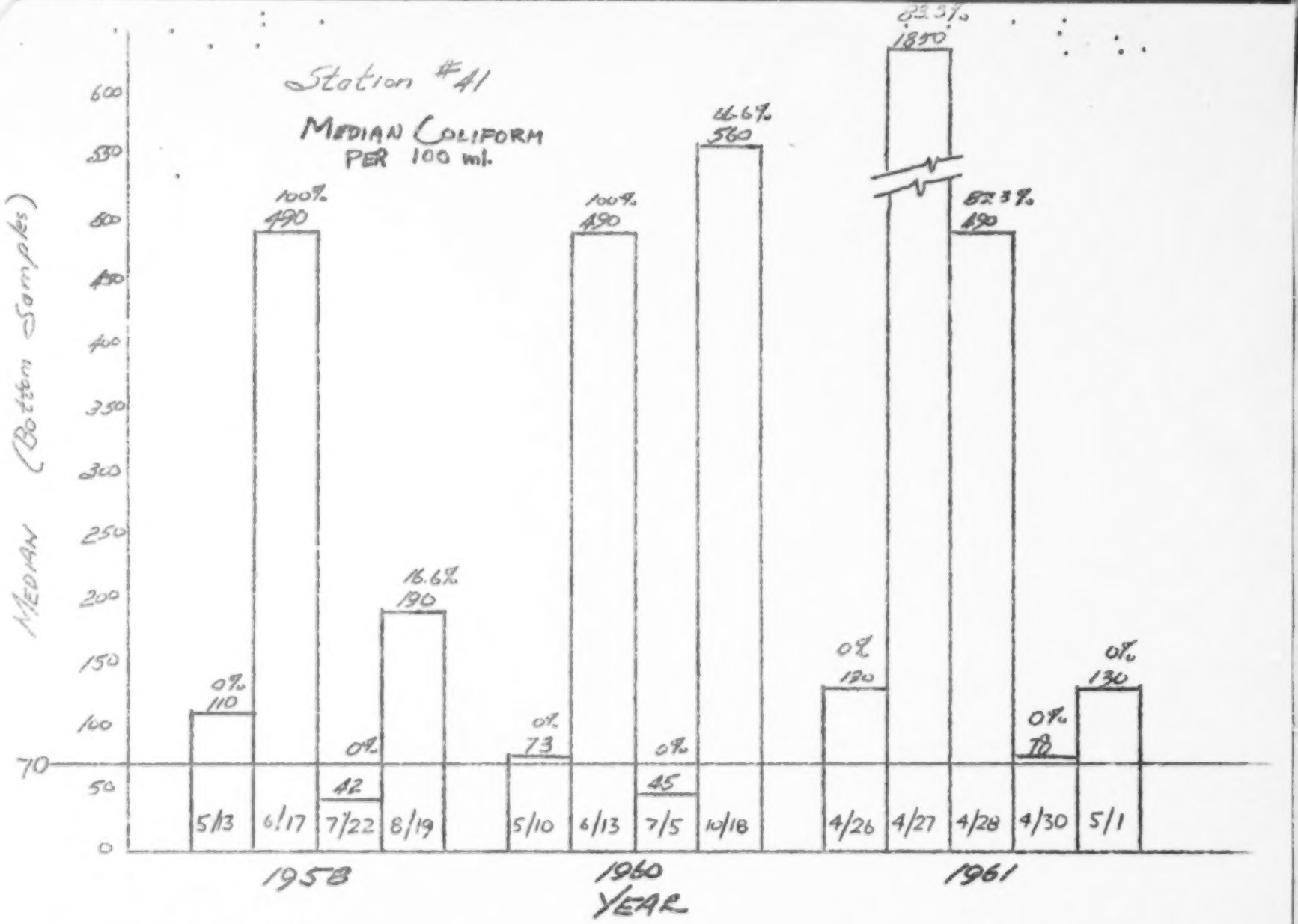


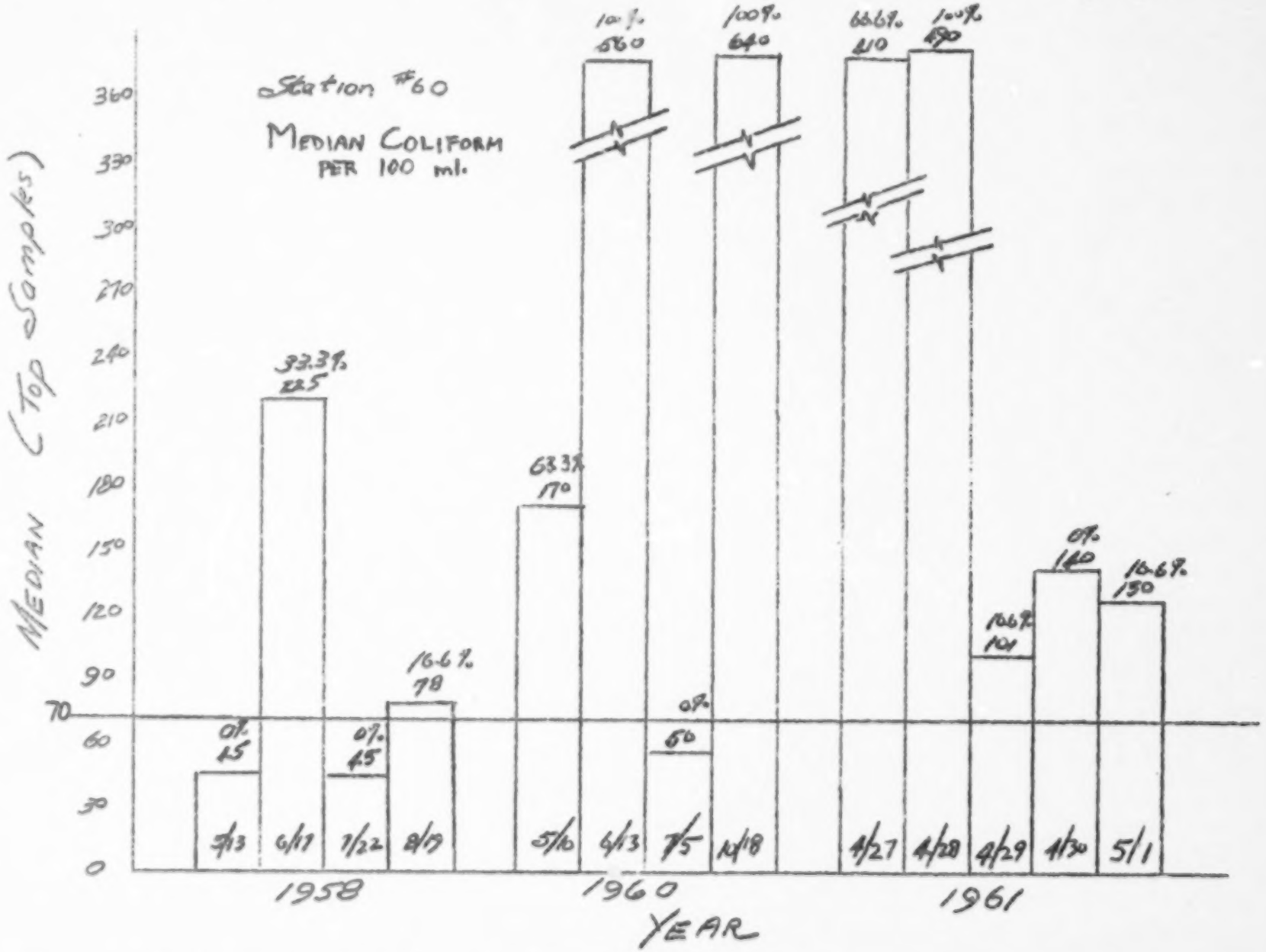
per 100 ml. and gradually decreases along both profiles towards station 13-10, where the ship channel cuts across the State line. While the yearly geometric mean densities at station 13-10 were 150, 360, and 210 per 100 ml. respectively in 1959, 1960 and 1961, samples taken along both the ship channel profile and the State line profile at eastern stations show an increasing coliform content. The three yearly geometric means at station 18 were 230, 470, and 1,500 per 100 ml. Similar increases in yearly geometric means will be noted at stations 3, 5, and 7.

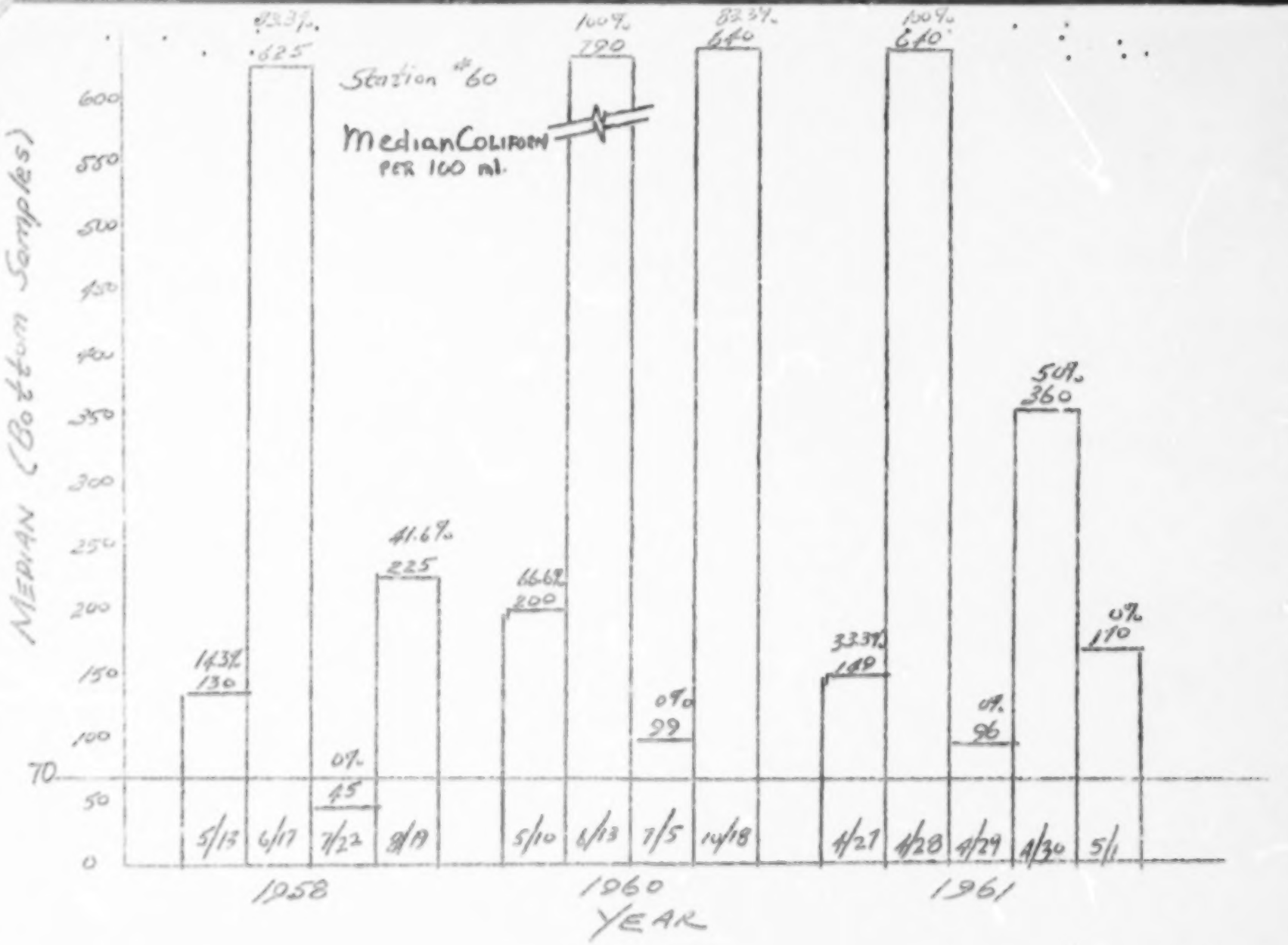
With regards to the quality of the waters overlying the shellfish beds, the extensive tidal cycle data for two sampling stations during 1958, 1960 and 1961 were considered. Median daily MPN values for the 6 to 12 daily top samples and bottom samples generally collected monthly between April and August are presented in Figure ___. Consideration of these data indicate that at both stations median values for top samples exceeded 70 MPN per 100 ml. (used as a criteria of the waters of a shellfish bed) on 11 of 13 sampling days, and median values for bottom samples exceeded 70 MPN per 100 ml. on 12 of 13 sampling days. With regard to the criteria that not more than 10% of the values in a series of samples should exceed an MPN of 230 per 100 ml., it was found that on 6 or more of the 13 sampling days between 15% and 100% of the samples exceeded 230 MPN per 100 ml. for both top and bottom sampling stations.

A large number of MPN data were collected during the last four years by the four agencies who are principally responsible for investigating the water quality of Raritan and Lower Bays. Consideration of the data indicated that the development of a graph of lines of equal


STATION # 41
MEDIAN COLIFORM PER 100 ml.
MEDIAN (Top Samples)
YEAR
1958
1960
1961
360
330
300
270
240
210
180
150
120
90
70
60
50
0
80%
490
3238
94
0%
20
0%
135
0%
130
833%
280
0%
45
50%
280
833%
2550
700%
475
666%
330
16.6%
18
50%
230
5/13
6/17
7/22
8/19
5/10
6/13
7/5
10/18
4 27
4/28
4/29
4/30
5/1


Station #41
MEDIAN COLIFORM PER 100 ml.
MEDIAN (Bottom Samples)
600
550
500
450
400
350
300
250
200
150
100
70
50
0
0%
110
100%
490
0%
42
16.6%
190
0%
73
100%
490
0%
45
66.6%
560
0%
120
83.3%
1850
0%
70
83.3%
490
0%
130
5/13
6/17
7/22
8/19
5/10
6/13
7/5
10/18
4/26
4/27
4/28
4/30
5/1
1958
1960
1961
YEAR

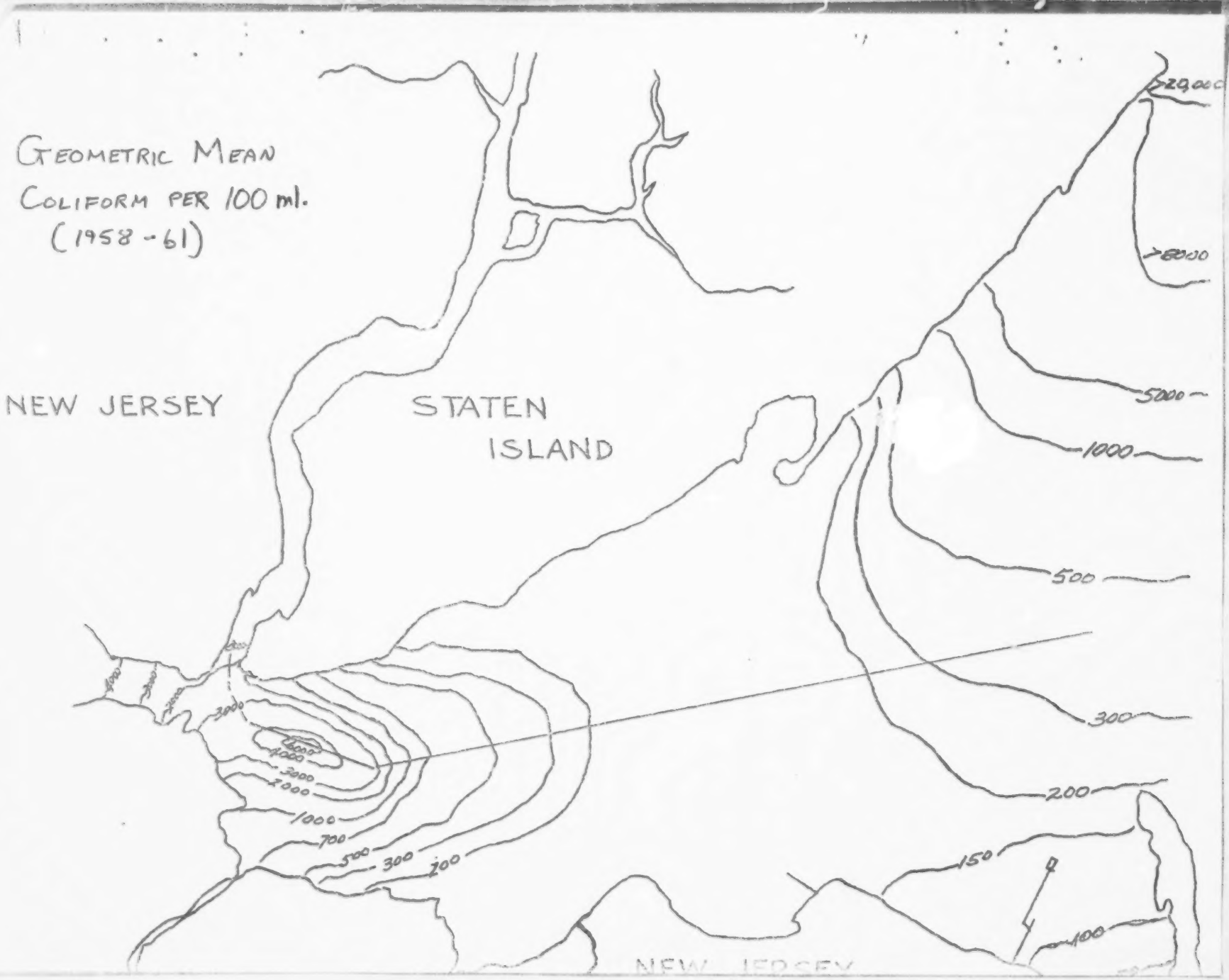

Station #60
MEDIAN COLIFORM PER 100 ml.
MEDIAN (Top Samples)
360
330
300
270
240
210
180
150
120
90
70
60
30
0
0% 45
33.3% 225
0% 45
16.6% 78
63.3% 170
100% 560
0% 60
100% 640
66.6% 410
100% 490
16.6% 104
0% 140
16.6% 130
5/13
6/11
7/22
8/17
5/10
6/13
7/5
11/18
4/27
4/28
4/29
4/30
5/1
1958
1960
1961
YEAR


Station #60
Median Coliform per 100 ml.
MEDIAN (Bottom Samples)
600
550
500
450
400
350
300
250
200
150
100
70
50
0
833%
625
1007.
790
8237.
640
1007.
640
507.
360
41.67%
225
667%
200
143%
130
0%
45
0%
99
3337.
149
0%
96
0%
170
5/13
6/17
7/22
8/17
5/10
6/13
7/5
14/18
4/27
4/28
4/29
4/30
5/11
1958
1960
1961
YEAR

coliform density for the entire area on a monthly or yearly basis was not feasible. Accordingly, in order to develop a general, area-wide presentation, all MPN data collected over the four-year period were analyzed to determine a single geometric mean for each sampling station and the chart was subsequently developed. The results is a generalized picture of coliform conditions in Raritan and Lower Bays. These data confirm the previously described float studies and the profiles along the Staten Island beaches, the ship channel and the State line.

Previously-mentioned float studies indicate that waters exiting from the Narrows swirl back in a general clockwise direction over the shallow shoal areas adjacent to the eastern Staten Island beaches. Figure ___ indicates this characteristic. The intensity of coliform content in offshore waters varies from 20,000 MPN per 100 ml. at the Narrows to about 8,000 per 100 ml. southwest of the Narrows, and decreases to approximately 200 MPN per 100 ml. in the vicinity of Great Kills Park. With regard to float studies indicating tidal transport from the Narrows to the area of Sandy Hook, Figure ___ indicates coliform intensities varying from 20,000 per 100 ml. at the Narrows to approximately 500 per 100 ml. at the State line, and about 100 per 100 ml. in lower Sandy Hook Bay.

In western Raritan Bay Figure ___ indicates high coliform densities in the vicinity of the mouth of the Raritan River, the southern end of the Arthur Kill and the general area of the Middlesex County outfall. Furthermore, as previously indicated by the profile

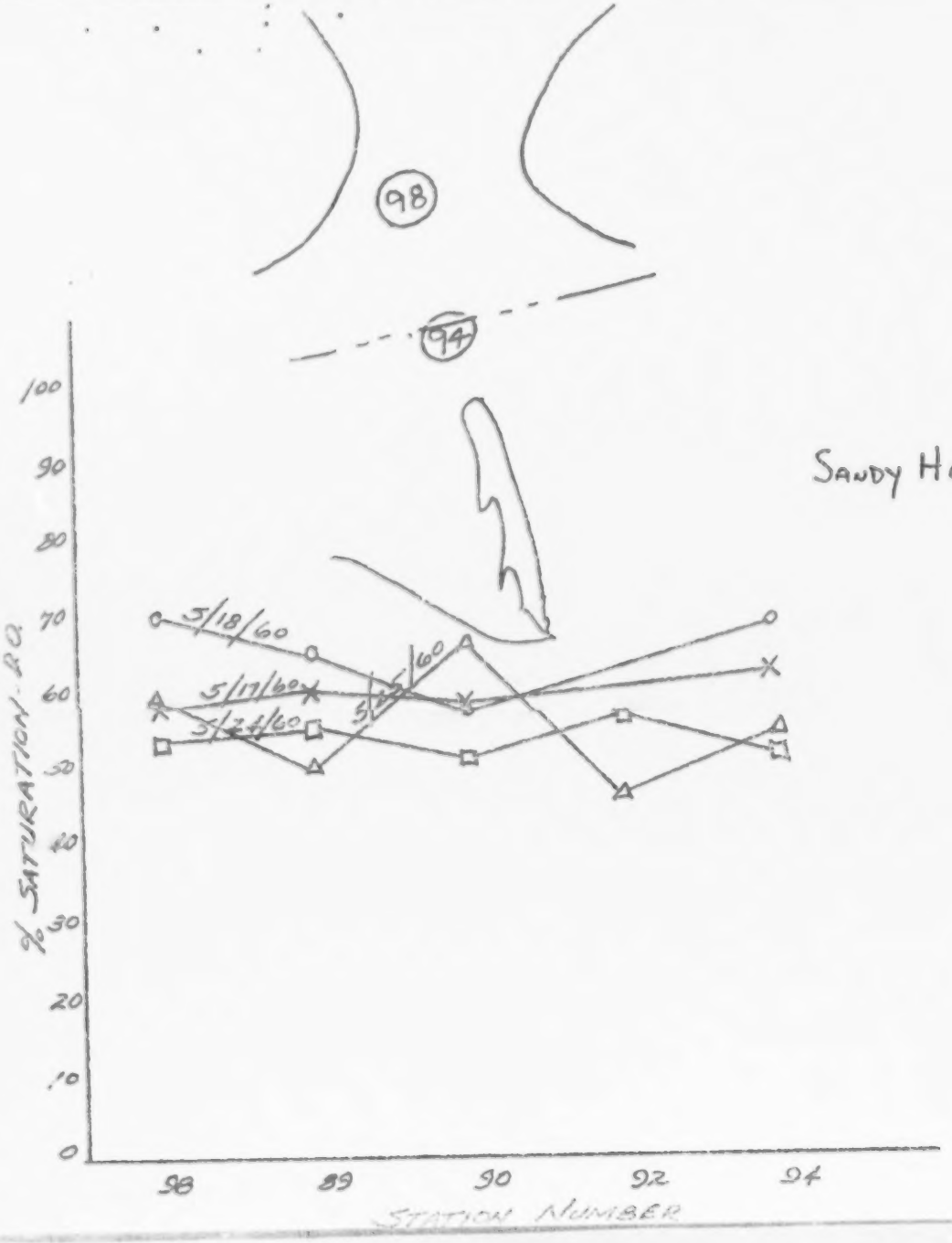

GEOMETRIC MEAN
COLIFORM PER 100 ml.
(1958 - 61)
NEW JERSEY
STATEN
ISLAND
>29,000
>6000
5000
1000
500
300
200
150
100
6000
4000
3000
2000
1000
700
500
300
200
NEW JERSEY

data in Figures ___, ___ and ____, a general improvement in water quality occurs in Figure ___ as one proceeds eastward from western Raritan Bay towards Lower Bay.

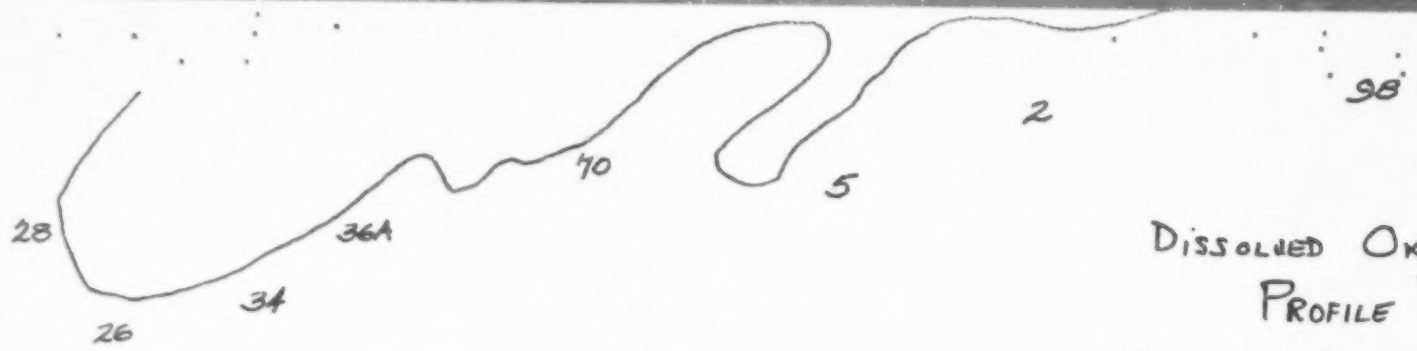
Dissolved oxygen data were also considered in an effort to establish water quality throughout Raritan and Lower Bays. Recent data collected on four days by the New York State Conservation Department for stations south of the Narrows on a southerly line perpendicular to the State line indicated values generally in excess of 50 per cent saturation with little variation over a distance of approximately 4 miles are presented in Figure ___. On the other hand, data collected by the same agency, as presented in Figures ___ and ___ on profiles running from the mouth of the Arthur Kill along the Staten Island shore and approximately 1 mile off the shore, indicated dissolved oxygen station values between 25 per cent saturation and supersaturation. It will be noted that 9 of the samples in Figure __ and 9 of the samples in Figure ___, indicated dissolved oxygen saturation values of less than 50 per cent, and were, therefore, below the Compact class "A" requirements. Furthermore, while the dissolved oxygen content is generally low in the western section of Raritan Bay (station 28), a consideration of the data along the profile indicates that the water quality is generally improving towards the eastern section of Lower Bay.

Review of Published Reports

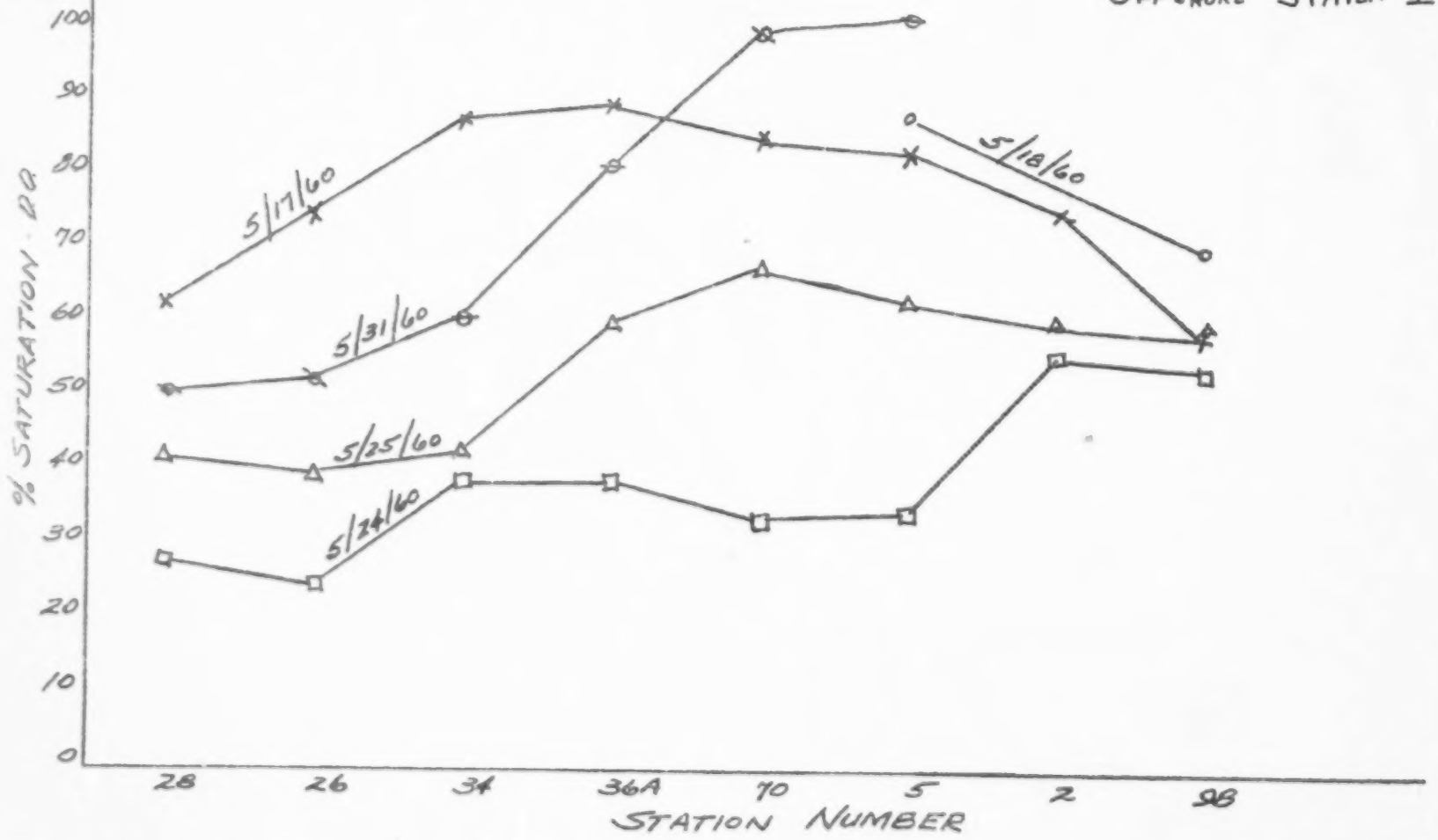
As previously presented in the section entitled "Past Studies", the water quality of the waterways under consideration has been described

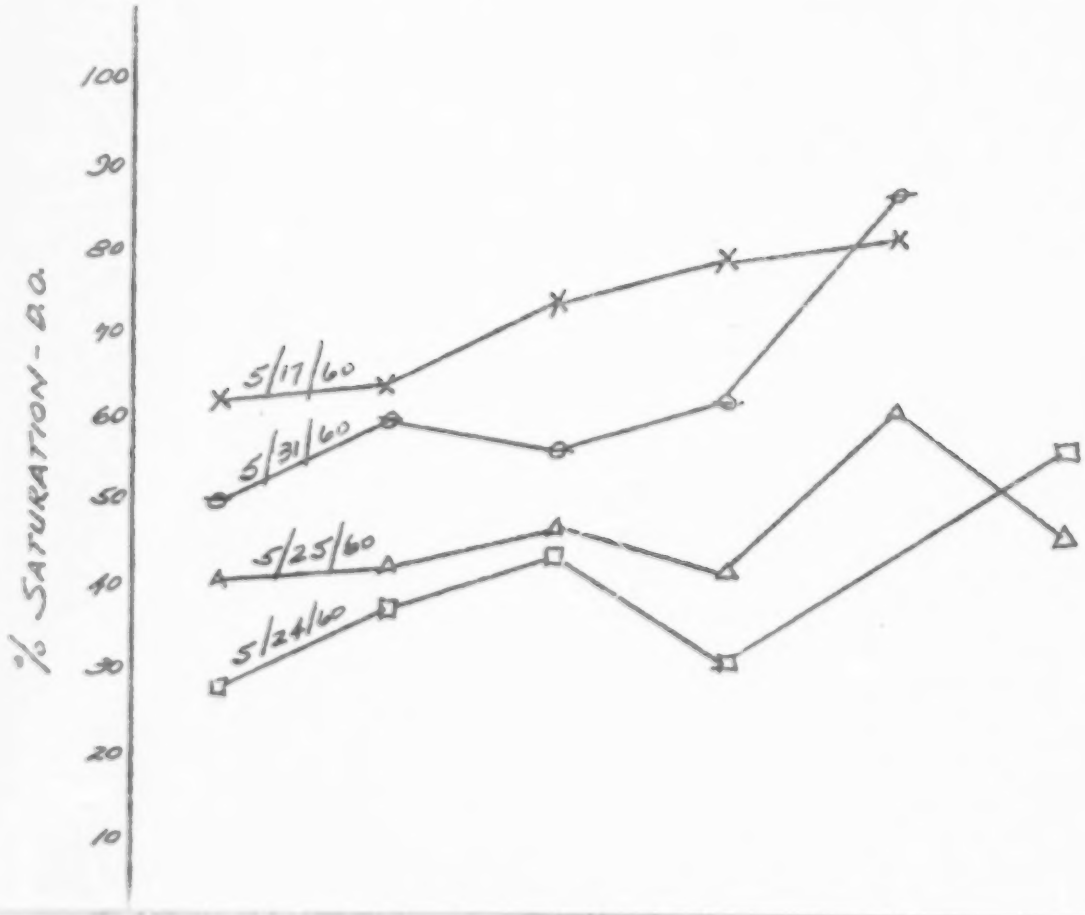


DISSOLVED OXYGEN
PROFILE
SANDY HOOK — THE NARROWS 1960



Dissolved Oxygen Profile
Offshore Staten Island





DISSOLVED OXYGEN
PROFILE
NEW YORK WATERS
NORTH OF STATE LINE
1960

as polluted by the various agencies and authors. A review of the more recent reports follows:

1. Interstate Sanitation Commission Report - 1958

The Commission conducted a survey of the Arthur Kill during June and July 1957. The report indicated that the Compact requirements for Class "B" waters were not being met for 60 percent of the Kill's total length with the greatest pollution occurring at about 8.3 miles north of Raritan Bay. The Commission concluded:

"(1) The Interstate Sanitation Commission Compact requirements for Class "B" waters are not being met from a point near Station #2 [opposite the Elizabeth River] to a point between Station #12 and #13 [between Boynton Beach and Smoking Point].

"(2) The waters at Station #7 [mouth of the Rahway River] contain the greatest pollution.

"(3) There is a "slug" of pollution in the Arthur Kill about 6.4 miles in length, having 30% or less saturation of dissolved oxygen, and it moves to and fro with the ebb and flood of the tide.

"(4) Station #7 is the only station continually under the influence of the "slug" of pollution."

2. Summary Report on the Quality of Waters in Raritan and Lower Bays - 1958

This report submitted by Harold F. Udell evaluated considerable data and presented the following conclusions:

"(1) Bacterial pollution in Raritan and Lower Bays is relatively high at the head of Raritan and the entrance of Lower Bay but decreases steadily, westerly in Lower Bay and easterly in Raritan Bay.

"(2) The organic pollution in Raritan - Lower Bays does not present a problem because of available dilution and effects of natural purification.

"(3) The pollution in Arthur Kill has a degrading effect on the waters at the head of Raritan Bay.

"(4) Pollution contributed by shipping has not been determined.

"(5) Pollution in the waters of the westerly portion of Raritan Bay should be re-evaluated after the Middlesex County Sewerage Authority Treatment plant has operated for a suitable length of time."

3. Review Copy of New York City Water Survey Series, Report No. 3 - Arthur Kill - Kill Van Kull - June 1960

This report was prepared by Hazen and Sawyer for the classification of Arthur Kill and Kill Van Kull by the New York State Water Pollution Control Board. The report summarizes the condition of the waters of Arthur Kill and Kill Van Kull as " .... are generally grossly polluted". Further

the report states that "the quality of waters in Arthur Kill and Kill Van Kull at present is almost wholly a function of the sewage and industrial waste load imposed from New Jersey".

4. Recommended Classification of Surface Waters in the Area of and Including West and Lower Bay and Raritan Bay - June 1960

The report was prepared by the New York State Conservation Department - Shellfisheries Management Unit for the New York State Water Pollution Control Board. The report reviewed present conditions in Raritan and Lower Bays and found the following areas to be polluted:

> The waters lying east of a line running in a north-south direction from Great Kills harbor to the New York-New Jersey State line; also those waters of New York State lying west of Princess Bay.

WATER USE

Shipping

New York has long been recognized as the nation's leading port in tonnage handled and passengers carried. In 1955 the port of New York handled 58,265,000 short tons of waterborne commerce entering and leaving through the lower entrance channels (The Narrows, Raritan River, Arthur Kill, Staten Island etc.). There were 36,355 vessel trips recorded and 525,644 passengers were transported. The Arthur Kill handled about 18,000,000 tons of the previous total with approximately 2,000 vessel trips.

But, total tonnage entering and leaving the harbor area is only one side of a broader picture. There is a great deal of activity generated by intraport shipping. The Arthur Kill has been described as the nation's busiest inland waterway. "A daily average of twenty-four deep-draft vessels passes through the channel every day carrying more than 100,000,000 tons of cargo a year." This may be emphasized by comparing the total tonnage entering and leaving (including intraport shipping) with the totals for the entire New York District. In 1955 the study area handled 108,588,770 tons of cargo which represented 56% of the total gross harbor tonnage of 192,316,353 tons. Oil, gasoline, crude petroleum and residual fuel oil accounted for 65,073,742 tons of the total gross tonnage of the study area traffic in 1955 or about 58%.

Further expansion of the Arthur Kill's facilities is contemplated. A recent newspaper article described future improvements including "the widening of the Arthur Kill channel to a minimum width of 800 feet, instead of 400 feet and 500 feet now in certain areas, and a deepening throughout the channel of forty and forty-five feet."

Smaller, but still very significant amounts of tonnage, are regularly handled by the New Jersey shore ports located from Sandy Hook Bay to Raritan Bay. Sandy Hook Bay handled 59,837 tons of inedible fish and petroleum products in 1959.

The Linden-Rahway-Woodbridge area of New Jersey, which the Arthur Kill serves is the largest oil refining and storage center on the eastern seaboard.

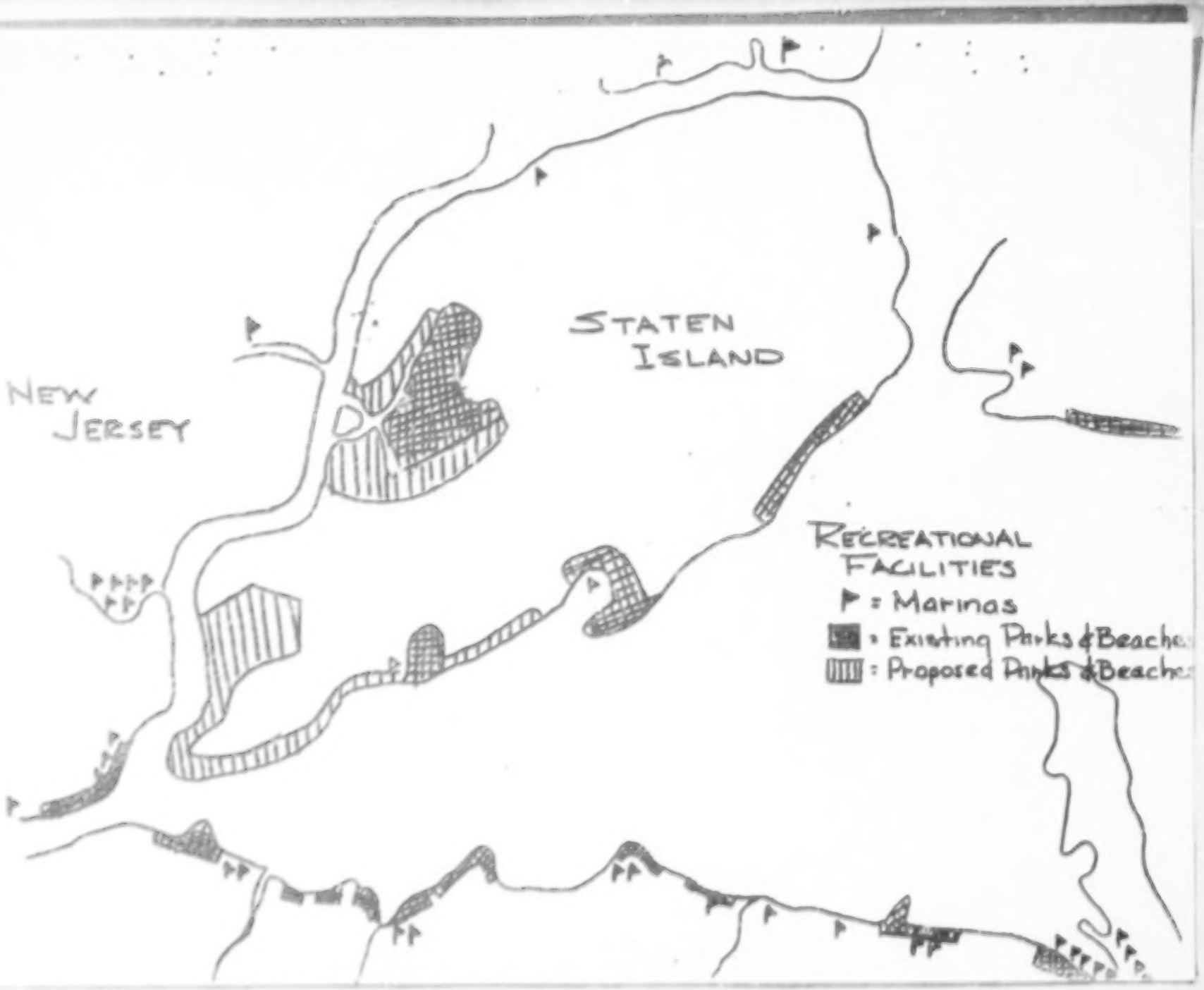
Bathing

Besides being used by shipping and manufacturing interests the waters of the study area attract sizable numbers of bathers. The City of New York maintains three beaches on Staten Island fronting on the Raritan and Lower Bay. South Beach (2.5 miles), Great Kills Park (2.0 miles) and Wolfe's Pond Park (0.4 miles) account for 4.5 miles of the city-wide total of 17.56 miles of bathing beach frontage. Attendance at the Staten Island beaches was 750,000 in 1959 and 651,000 in 1960. An unofficial estimate of the total beach attendance in the city for bathing purposes for the past year has been placed at 65,000,000. Although Staten Island has one fourth of the beach frontage it is presently serving only one per cent of the bather load.

To give some idea of the amounts of acreage, capital expenditures, maintenance and operations costs, property values, and receipts involved in the operation of the facilities on Staten Island, the following data was gathered from the Department of Parks of the City of New York.

New York City has expended a considerable amount of money in its park facilities on Staten Island. The three park areas previously mentioned were built at a total capital expenditure of $10,634,000. Their approximate property value is now rated at $14,337,550. Maintenance and operation costs for the past two years totaled $708,677. Income from parking, bathhouse, admissions, refreshment stands etc. for the past two years was approximately $53,000. There are picnic facilities at Wolfe's

Pond and South Beach. The Boardwalk and South Beach area, Wolfe's Pond and Great Kills comprise a total area of 2109 acres. Recent statistics on the city-wide park area total are 34,673 acres in 1960. Portions of the facilities at South Beach are under renovation and reconstruction with the anticipation of increased attendance. Unauthorized bathing takes place intermittently along a large portion of the remaining Bay frontage on Staten Island. There are also a large number of private bathing areas in this section.


STATEN ISLAND
NEW JERSEY
RECREATIONAL FACILITIES
▶ = Marinas
= Existing Parks & Beaches
= Proposed Parks & Beaches

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STATEN ISLAND BEACH FACILITIES

Acreage Beaches and Facilities		Capital Expenditures for Construction	
Great Kills	1246.00	Great Kills	$1,750,000
Wolfe's Pond	224.365	Wolfe's Pond	100,000
South Beach	638.5	South Beach	8,784,000
Total	2108.865	Total	$10634,000

Maintenance and Operation Costs per year (2 years)

	1959	1960	
Great Kills	$106,564	$105,184	
Wolfe's Pond	47,798	49,531	
South Beach	198,865	200,735	- 2 Year Total $708,677

Approximate Property Value

Great Kills	$3,935,500	
Wolfe's Pond	1,029,600	
South Beach	9,372,450	- Total $14,337,550

Gross Receipts from Refreshment Stands and Related Concessions

	1959	1960
Great Kills	$18,321	$18,400
Wolfe's Pond	10,000	12,000
South Beach	$25,150	37,000
Total	$53,671	$67,400

(The City's revenue is about 10% of the gross receipts.)

Income from Parking, Bathhouse, Beach Admissions, etc.

		Parking	Bathhouse	Admissions
1959	Great Kills	$16,134.00	$2742.50	---
	Wolfe's Pond	8,728.00	---	---
	South Beach	4,158.50	1006.90	$8,196.20
1960	Great Kills	17,175.00	2443.20	---
	South Beach	7,693.00	1597.90	$13,856.40
	Wolfe's Pond	7,984.50	---	---

2 Year Total of all income $81,756.10

Picnic Facilities

	Tables	Benches	Fireplaces
Great Kills	---	---	---
Wolfe's Pond	114	228	32
South Beach	33	66	---
Total	147	294	32

In New Jersey numerous beaches dot the shoreline from Sandy Hook across to Keyport. At least fourteen beaches are located in this area.

Beaches in New Jersey

Keyport	Perth Amboy
Cliffwood Beach	Union Beach
Charlies Beach	Keansburg
Seidlers Beach	Ideal Beach
Lawrence Harbor	Leonardo
Morgan's Beach	Atlantic Highland
South Amboy	Highlands

Boating

In all probability the one major water activity which has enjoyed the greatest increase in public participation since 1950 had been boating. Annual expenditures for boating in the U.S. have quadrupled from $645,000,000 in 1951 to over two-and-one half billion dollars in 1960. The states of New York and New Jersey have been among the foremost leaders of this boating boom. As of October 1955 New York was ranked first in the nation on the basis of undocumented boats registered with 64,346 and New Jersey was fourth with 30,527 out of a total 541,571.

A better indicator of boating's popularity within the metropolitan harbor area is the National Association of Engine and Boat Manufacturers' estimate of 368,500 outboard motors being used in the New York area as of December 31, 1959. Using a general estimate of about three persons per boat (and not even considering sailing craft) the above figures can be used to show that about 1,000,000 people use pleasure boats in the Metropolitan area. The general study area contains approximately 10% of the Metropolitan total. Thus, one can estimate conservatively that about 100,000 people enjoy some form of boating activity in the study area. Boats entering the above category would be of the charter variety. Recent statistics released by the Corps of Engineers show that more than 400,000 passengers were carried by ships working out of Sandy Hook Bay, Cheesequake Creek, Matawan Creek and the Shrewsbury River in New Jersey.

Marinas

In the general study area there are about 45 recognized marinas with over 2500 berths available for use by pleasure and commercial craft. The greatest concentration is in New Jersey. At an average cost of $2500 per pleasure boat this would amount to an investment of $6,250,000 but this is at best an indicator of only a portion of the money tied up in pleasure craft. Not until both New Jersey and New York have taken over the licensing and registration of commercial and pleasure craft from the Coast Guard and have extended their procedures to all craft will a really accurate idea of the economics of boating become evident.

One public marina is operated by the city on Staten Island on a concession basis. Its initial season was 1959 when 70 boats were berthed and $3,275 were realized in gross receipts. In 1960 the number of boats berthed increased to 158 and the receipts totaled $4,075. The city receives approximately 10% of the gross receipts as its rental charge from the concession.

Fishing

Some of the most popular fishing grounds in the U.S. were once located in the Metropolitan New York Harbor area. As recently as 1956 the New Jersey Fish and Game Department reported a total catch of game and commercial fish of 28,694,792 pounds in the Sandy Hook Raritan Bay area.

As recently as 1952 the New Jersey Department of Conservation and Economic Development described the conditions relative to fishing on Raritan Bay, Sandy Hook Bay, Lower New York Bay, and the Navesink and Shrewsbury River systems as follows:

"Although there is considerable pollution in Raritan Bay, porgies, fluke, flounders, weakfish and some bluefish are taken there. Lower New York Bay and Sandy Hook Bay are heavily fished by boats of all descriptions. Among the species taken are flounders, porgies, fluke, bluefish, snapper blues, striped bass, weakfish, croakers and crabs."

"The Navesink and Shrewsbury Rivers are well-known for their striped bass fishing. Anglers, who have learned to like a striper, make consistently good catches here. Among other species taken are flounder, fluke, porgies, eels, snapper blues and crabs."

"Twenty-nine rowboat and U-drive liveries are scattered throughout this area, and party and charter boats leave from Morgan, Leonardo,

Highlands and Atlantic Highlands. This area is also fished by boats sailing from Staten Island, the Battery, and Long Island ports."

In 1959 114,226 fishermen used the bay frontage on Staten Island. This figure decreased to 79,682 in 1960.

Shellfish

Until their closure on May 1, 1960 the shellfish beds of New York and New Jersey in Raritan Bay represented the last approved areas available in the immediate New York area for the taking of clams.

"To give some idea of the magnitude of the quantities involved, the New York State Conservation Department estimates that about 150,000 bushels of hard clams were dug from the New York State open areas of Raritan Bay in 1940 and data from the Bureau of Fisheries Bulletin for Monmouth and Middlesex Counties, New Jersey indicate that New Jersey production of hard clams from the bay amounts to perhaps 25,000 bushels or a total from the bay of 175,000 bushels."

In comparison with the New York State estimates of about 150,000 bushels of hard clams dug from the open areas of Raritan Bay in 1940, a perceptible decline is evidenced when one uses the more recent statistics taken from New York City Department of Health Reports from data furnished by the dealers:

YEAR	NUMBER OF BUSHELS	VALUE (Based on 1961 prices)
1948	15,000	$ 90,000
1949	40,000	240,000
1950	50,000	300,000
1951	38,000	228,000
1952	28,000	168,000
1953	26,000	150,000
1954	26,000	150,000
1955	22,000	132,000
1956	20,000	120,000
1957	22,000	132,000
1958	23,000	138,000
1959	25,000	150,000
1960	29,000	174,000

Conversion factors published by the U.S. Dept. of the Interior, Bureau of Commercial Fisheries show that one bushel of hard clams is equal to 11 pounds average weight. Also the price range for April, 1961 showed a $3 1/2 to 5 for chowder hard clams, $7 1/2-8 1/2 for cherrystones and $10-13 for little necks, (per bushel).

An average price of $6 per bushel was used in computing the values in the above list.

On the basis of $6 per bushel nut value; the 175,000 bushels given previously for 1940 the revenue derived from shellfishing then (1940) was about $1,050,000.

Recreation

In past years, especially prior to World War II, the New Jersey shore from Sandy Hook to Raritan Bay was a favorite Metropolitan vacation and excursion spot. One index of its popularity were the steamboats which regularly made trips between the Battery at the tip of Manhattan to Keansburg, New Jersey. The boats would often be filled to their capacity of 2000 passengers. Today only one boat continues this run making only two or three trips daily with attendance rarely over 300. The attractions at Keansburg are its boardwalk, amusements and the beach swimming and two salt water bathing pools.

Wildlife

Wild ducks are the principle species of game in this area. In February, 1957 two accidental oil spills, one at Perth Amboy and the second at Carteret in New Jersey wiped out an estimated 12,500 ducks. At the time the U.S. Fish and Wildlife Commissioner for New Jersey, Mr. Hanley, reported that this represented about one sixth of the total duck population of a total population of about 75,000. "The oil, he said, destroys the insulation of the feathers of the ducks, who make the area a favorite wintering ground because of the abundant mussels on which they feed."

ACTION OF OFFICIAL AGENCIES

There are several agencies, standards and laws which govern water quality in the New York Harbor area. Among these are the 1888 Harbor Act which prevents "obstructive and injurious deposits within the Harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses". This law, along with the 1924 Federal Oil Pollution Act are enforced by a fleet of twelve launches maintained by the Harbor Supervisor, and more recently, by the Corps of Engineers.

The Interstate Sanitation Commission has jurisdiction over all waters in the Harbor area with the exception of fresh water rivers other than the Hudson. The Commission's function is to abate existing pollution and to protect against future pollution. The Commission is empowered to establish dates for the construction of required treatment works after holding hearings and conducting investigations.

In November 1954, upon the request of the Interstate Sanitation Commission, New York City submitted a time schedule for the second phase of its pollution control program which in brief requested an amendment to extend the time of completion of the second phase from 1959 to 1964. The Commission at first refused to give an extension of time to New York City without evidence of the determination and ability of the City to finance such a program. Since that time the Board of Estimate and the City Planning Commission adopted resolutions announcing their determination to provide the necessary funds for the water pollution con-

trol program. In 1957 the Commission issued a new order fixing a progress schedule and extending the time for completion of the entire New York City program from 1959 to December 31, 1967. The proposed New York City program is shown in Table ___.

Water quality standards and classification procedures have also been established for the surface waters of New York State by the New York State Water Pollution Control Board.

New York State has contracted Hasen and Sawyer for the preparation of a report covering the classification of the New York portion of Arthur Kill. They have also contracted with the New York State Conservation Department to prepare a report covering the New York State portion of Raritan and Lower Bays. These reports have been prepared in draft form and are currently being printed by the State prior to the holding of hearing relative to the classification of these waters.

With respect to the Industrial Wastes the Interstate Sanitation Commission's report of 1959 reported that " ... the industrial wastes still discharging raw must receive attention. The Arthur Kill is such an area and has a larger concentration of industry than any other portion of our District ...."

"Since the majority of industry is on the New Jersey side of the Arthur Kill, the Commission has worked very closely with the New Jersey State Department of Health in the study of the problem. A joint meeting was held with the industries which contribute the greatest volume of

TABLE ___

NEW YORK CITY POLLUTION ABATEMENT PROGRAM

First Phase - Completed

Area	Capacity in MGD	Cost in Dollars
Wards Island	220.	$ 31,600,000
Hunts Point	120.	26,000,000
City Island - Hart Island	1.5	700,000
26th Ward	60.	9,400,000
Coney Island	70.	5,900,000
Owls Head	160.	23,000,000
Tallmans Island	40.	5,700,000
Jamaica Bay	65.	7,000,000
Bowery Bay	120.	42,000,000
Rockaway	15.	6,400,000
Port Richmond	10.	3,100,000
Oakwood Beach	15.	8,500,000
	896.5	$169,300,000

Second Phase - Proposed for Completion by January 1, 1963

	Capacity in MGD	Target Dates
Wards Island Extension	60.	1961
North River	220.	1964
Hunts Point Extension	30.	1967
Newtown Creek	310.	1963
City Island Extension	1.5	1966
Coney Island Extension	40.	1958
Red Hook	40.	1967
Tallmans Island Extension	10.	1961
Welfare Island	1.	1965
Jamaica Bay Extension	35.	1960
Rockaway Extension	15.	1966
Port Richmond Extension	20.	1966
Bloomfield	3.	1966
Fresh Kills	2.	1967
Eltingville	3.	Indefinite
Tottenville	3.	1966

untreated industrial wastes into the Arthur Kill and acquainted them with the problem. It was decided that other meetings should be held with each industry so that its individual problems could be discussed in more detail. A number of such meetings have already been held between representatives of industry and the control agencies. These meetings have indicated that the industries are aware of the magnitude of this problem and are anxious to cooperate in reducing the amount of pollution being discharged. After a complete picture is obtained, the Commission and the New Jersey State Department of Health will determine the action that will be required to correct this condition.

The New York City Health Department has classified as Class "B" - polluted beach waters not recommended for bathing - the following areas in Staten Island: Atlantic Ocean, from the northerly boundary of Fort Wadsworth, southerly and westerly to Hunter Avenue., (including South and Graham Beaches); Atlantic Ocean, southerly from Fox Lane to and including the northeast quarter of Great Kills Beach; Atlantic Ocean, from Holton Avenue, westerly to Page Avenue (including Princess Bay).

APPENDIX A

SUMMARY OF SEWAGE TREATMENT PLANT PERFORMANCE FROM INTERSTATE SANITATION COMMISSION RECORDS

SUMMARY OF HIGHLANDS SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
	Mgd.	Eff. PPM	Percent Removed	Eff. P.E.*	Eff. PPM	Percent Removed	Eff. P.E.*	# over 1/ml
4/30/58	0.452	66	57	1242	60	47	1356	0
6/18/58	0.370	82	66	1264	93	62	1720	0
10/21/58	0.4*	69	74	1152	97	46	1940	0
5/6/59	0.4*	58	75	960	100	54	2000	0
6/7/59	0.4*	48	82	801	152	50	3040	50
8/25/59	0.4*	87	58	1451	138	35	2760	0
10/28/59	0.4*	68	46	1136	86	38	1720	0
12/15/59	0.4*	63	63	1051	62	59	1240	0
5/17/60	0.4*	73	65	1217	113	31	2260	25
8/1/60	0.4*	53	73	881	117	49	2340	25
8/22/60	0.4*	90	49	1501		No Samples Taken		0
9/2/60	0.4*	84	42	1401	63	36	1260	0
3/28/61	0.4*	87	47	1451	78	36	1560	25
6/5/61	0.4*	103	55	1718	111	38	2220	0
Average				1231			1955	

Failure to meet Compact requirements for Suspended Solids removal - 7/14 visits
Failure to meet Compact requirements for Coliform removal - 0/14 visits

* Estimated

SUMMARY OF ATLANTIC HIGHLANDS SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	over
	Mgd.	PPM	Removed	P.E.*	PPM	Removed	P.E.*	1/ml
4/30/58		48	45		67	33		0
6/17/58	0.510	57	33	1212	103	0	2680	0
10/7/58	0.277	39	69	450	116	7	1635	0
5/7/59	0.300*	75	19	938	112	neg.	1380	0
7/1/59	0.369	107	17	1646	184	neg.	3395	25
8/26/59	0.355	107	16	1585	154	6	2735	75
11/4/59	0.226	130	11	1286	102	27	1155	25
5/18/60	0.667	38	69	1051	83	34	2780	0
8/1/60	0.502	33	75	688	120	10	3000	0
8/22/60	0.5*	41	61	854	No Samples Taken			
9/21/60	0.5*	121	neg.	2522	100	neg.	2500	100
9/27/60	0.5*	65	54	1355	113	7	2825	75
3/23/61	0.5*	40	30	834	67	16	1675	0
5/9/61	0.741	19	77	396	66	35	1650	0
Average				1136			2309	

Failure to meet Compact requirements for Suspended Solids removal - 9/14 visits
Failure to meet Compact requirements for Coliform removal - 3/13 visits

* Estimated

SUMMARY OF LEONARDO REGION TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	# over
	Mgd	PPM	Removed	M.F.*	PPM	Removed	P.O.*	1/ml
7/8/58	0.015*	11	74	6.9	16	36	12	75
6/30/59	0.015*	13	42	8.1	15	32	11	25
6/30/60	0.015	----------	----------	No Samples Taken	----------	----------	----------	100
1961	No visits So Far							
Average				7.5			12	

Failure to meet Compact requirements for Suspended Solids removal - 0/2 visits
Failure to meet Compact requirements for Coliform removal - 2/5 visits

* Estimated

SUMMARY OF EXAMINING OFFICE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	A over
	Mgd.	PPM	Removed	P.p.d.*	PPM	Removed	P.p.d.*	3/ml
4/23/58	1.57	115	none	7301	46	18	2825	300
6/24/58	1.53	116	15	7401	56	59	4285	75
10/28/58	1.64	104	18	7065	46	19	4030	360
2/6/59	1.37	79	24	4852	43	45	3803	90
6/24/59	1.44	851	70	48975	93	57	6695	75
8/25/59	1.66	77	64	5389	130	30	9230	0
11/17/59	1.27	71	21	3757	39	49	2413	60
3/25/60	1.19	92	22	4568	55	27	3272	75
8/1/60	3.11	61	33	10534	78	44	12124	75
8/23/60	2.74	117	48	13366	No Samples Taken			15
10/6/60	1.38	66	45	3793	26	62	1794	50
3/21/61	1.82	56	10	4250	41	27	3731	200
5/10/61	1.45	97	none	5865	51	25	3697	90
Average				9517			4736	

Failure to meet Compact requirements for Suspended Solids removal - 11/13 visits
Failure to meet Compact requirements for Coliform removal - 9/13 visits

* Estimated

SUMMARY OF KANSAS CITY TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	# over
	Mgd.	PPM	Removal	P.E.*	PPM	Removal	P.E.*	1/ml
4/23/58	0.800	60	49	2260	111	8	4440	
6/25/58	0.8*	104	25	3469	173	14	6920	25
10/22/58	0.8*	105	43	3426	184	16	7360	75
5/13/59	0.8	53	73	1768	121	27	4840	100
6/30/59	0.8	81	61	2695	165	24	6600	50
8/26/59	0.8*	104	38	3469	176	25	7040	75
11/18/59	0.8*	68	76	2268	103	55*	4120	67
6/1/60	0.8*	77	55	2568	157	22	6280	100
8/2/60	0.8*	27	63	900	136	29	4240	25
8/23/60	0.8*	71	32	2320	No Samples Taken			75
2/28/60	0.8*	53	53	1768	104	20	4160	100
3/15/61	0.8*	51	41	1701	93	18	3720	100
5/10/61	0.8*	51	46	1701	122	23	4880	100
Average				2285			5334	

Failure to meet Compact requirements for Suspended Solids removal - 9/15 visits
Failure to meet Compact requirements for Coliform removal - 9/12 visits

* Estimated

SUMMARY OF KNOLLCROFT BEAUCE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	M.P.N.
	Mgd.	PPM	Removed	P.E.*	PPM	Removed	P.E.*	/ml
5/12/61	----------	----------	No Samples Taken	----------	----------	----------	----------	100

Failure to meet Compact requirements for Coliform removal - 1/1 visit

*Estimated

SUMMARY OF SAYREVILLE-MONSEN SEWAGE TREATMENT PLANT PERFORMANCE
FROM INFORMATION FURNISHED COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	# over
	Mgd.	PPM	Removal	P.E.*	PPM	Removal	P.E.*	1/ml
4/24/58	0.100	----------			No Sample Taken			0
9/23/58		-	-	-	-	-	-	0
6/16/59	0.074	-	-	-	-	-	-	0
9/17/59	0.115	-	-	-	-	-	-	0
12/3/59	0.094	-	-	-	-	-	-	0
6/30/60								0
8/24/60	0.156	75	70	456	No Sample Taken			0
5/12/61	0.110	43	64	197	164	90	903	0
Average				343			903	

Failure to meet Compact requirements for Suspended Solids removal - 0/2 visits
Failure to meet Compact requirements for Coliform removal - 0/2 visits

* Estimated

SUMMARY OF SOUTH ARROY SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION REPORTS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
	Mgd.	Eff. PPM	Percent Removal	Eff. P.E.*	Eff. PPM	Percent Removal	Eff. P.E.*	M.P.N. 1/ml
5/6/58	0.735	56	66	1735	80	38	2815	0
6/30/58	0.595	67	74	1664	114	52	3190	25
10/21/58	0.600*	62	65	1551	147	40	4410	0
5/5/59	0.575	69	69	1655	140	35	5175	0
6/23/59	0.600*	66	70	1651	160	44	4800	0
9/1/59	0.600*	91	55	2277	356	11	4680	25
11/1/59	0.600*	65	69	1626	136	24	4080	25
6/7/60	0.56*	62	74	1447	178	39	5340	25
8/2/60	0.6*	46	75	1150	145	34	4230	25
8/24/60	0.6*	67	66	1676	No Samples Taken			0
10/19/60	0.6*	53	72	1496	147	33	4410	25
5/8/61	0.6*	25	87	975	137	28	4110	25
6/13/61	0.6*	30	89	1251	154	25	4620	25
Average				1506			4307	

Failure to meet Compact requirements for Suspended Solids removal - 1/13 visits
Failure to meet Compact requirements for Coliform removal - 0/13 visits

* Estimated

SUMMARY OF SAYREVILLE-RARITAN SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	Power
	Mgd.	PPM	Removed	P.Lb.	PPM	Removed	P.Lb.	1/ml
4/24/58	0.038*	----------		No Samples Taken	----------			0
9/23/58	0.045	"		"	"			0
6/18/59	0.030	"		"	"			0
9/17/59	0.019	"		"	"			0
12/3/59	0.017	"		"	"			0
6/30/60		"		"	"			0
8/24/60	0.042	58	68	100				0
4/4/61	0.045	56	22	104	74	49	185	0
Average				102			185	

Failure to meet Compact requirements for Suspended Solids removal - 1/2 visits
Failure to meet Compact requirements for Coliform removal - 0/8 visits

* Estimated

SUMMARY OF MIDDLESEX COUNTY SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	MLGW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff. PPM	Percent Removed	Eff. P.E.*	Eff. PPM	Percent Removed	Eff. P.E.*	# over 1/ml
6/30/58	29.77	50	84	62070	380	Neg.	477925	0
10/8/58	31.4	62	80	88159	387	7	550515	0
4/22/59	36.9	106	64	163089	367	17	564701	25
6/16/59	39.9	107	62	178017	412	6	685506	25
8/25/59	40.0*	165	81	275220	503	26	1006000	0
10/28/59	46.71	110	67	211734	444	16	869016	25
12/16/59	43.21	77	71	138736	369	18	664865	0
5/11/60	42.87	95	74	169829	475	13	1013875	0
8/2/60	52.08	56	77	78182	353	11	924420	25
8/23/60	50.37	172	39	361273	No Samples Taken			0
10/15/60	41.83	74	75	129079	375	16	784312	0
12/6/60	37.8	155	58	244520	493	10	931770	0
3/22/61	55.4	72	88	166332	291	21	806070	25
6/7/61	50.0*	63	76	131355	344	10	860000	0
Average				171175			779582	

Failure to meet Compact requirements for Suspended Solids removal - 2/14 visits
Failure to meet Compact requirements for Coliform removal - 0/14 visits

* Estimated

SUMMARY OF NORTH ANNOY SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	per over
	Mgd.	PPM	Removed	P.P.M.	PPM	Removed	P.P.M.*	1/ml
4/22/58	5.75	115	36	47465	114	20	32775	300
7/1/58	5.7	27	87	6483	59	24	28800	25
10/4/58	5.52	49	76	10663	82	51	21900	0
4/21/59	5.79	56	67	12911	152	62	38215	50
6/17/59	4.12	39	69	6814	97	41	19992	0
7/7/59	4.58	79	64	15491	66	59	19700	75
8/26/59	6.43	61	62	16346	122	52	59225	0
12/8/59	6.64	53	58	14678	156	neg.	51800	25
5/10/60	7.60	85	46	26958	145	7	55100	0
8/2/60	6.91	9	92	2994	185	26	63900	0
8/22/60	5.46	62	61	14115	No Samples Taken			50
9/15/60	----------	----------	----------	No Samples Taken	----------	----------	----------	----------
12/7/60	5.22	52	75	11319	126	25	32985	50
5/14/61	5.88	138	neg.	33931	55	neg.	16170	100
5/9/61	5.45	43	69	9754	104	66	28340	25
Average				14949			34469	

Failure to meet Compact requirements for Suspended Solids removal - 4/14 visits
Failure to meet Compact requirements for Coliform removal - 3/14 visits

*Estimated

SUMMARY OF WOODRIDGE-SENECA SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATES	MGD	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
	Mod.	Eff. PPM	Percent Removal	Est. Lbs.*	Eff. PPM	Percent Removed	Est. Lbs.*	Over 1/ml
4/9/56	3.9	35	78	5621	66	62	19670	
6/26/58	1.04	30	74	1470	185	34	6500	
10/22/58					No Samples Taken			
4/22/59	2.28	45	75	4270	134	56	15275	
7/2/59	1.25	42	60	2137	No Samples Taken			
8/27/59	1.11	36	70	1750	173	53	9600	
10/14/59	0.565	80	60	1808	94	19	2550	
12/10/59	0.903	42	68	1580	97	62		
6/23/60	1.01	23	89	968	135	40	6813	
7/28/60	2.19	38	56	3470	73	23	8000	
8/25/60	3.91	27	71	4402	No Samples Taken			
10/20/60	3.66	65	79	9535	182	52	22525	
5/18/61	4.34	35	81	2714	58	71	12585	
Average				5573			11470	

Failure to meet Compact requirements for Suspended Solids removal - 0/12 visits

*Estimated

SUMMARY OF CARTERET SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	over
	Mgd.	PPM	Removed	P.E.*	PPM	Removed	P.E.*	1/ml
5/29/58	2.18	82	86	7456		No Samples Taken		
7/28/58	1.65	110	66	7277	50	26	4080	
10/15/58	1.93	53	77	4266	50	62	4825	
4/22/59	2.17	172	79	15562	202	57	21915	
7/2/59	1.85	205	71	15638		No Samples Taken		
8/27/59	1.91	98	67	7798	292	54	27895	
11/10/59	1.93	91	59	7323		No Samples Taken		
6/23/60	1.72	69	50	4950	117	15	10062	
7/28/60	2.15	92	70	12095	69	3	10967	
8/25/60	3.0*	99	70	12384		No Samples Taken		
9/29/60	2.55	115	71	12228	114	8	14535	
3/30/61	3.12	51	55	6635	52	53	8112	
6/8/61	3.0*	37	83	4628	81	46	12150	
Average				9111			12715	

Failure to meet Compact requirements for Suspended Solids Removal - 1/15 visits

* Estimated

DATE	PLOT	
	Mgd.	Rf. %
12/4/59	28.76	56
6/23/60	20.45	44
7/18/60	17.45	64
8/10/60	15.32	74
10/25/60	26.82	41
4/5/61	27.96	43
Average		

Failure to meet Company requirements for Rainbow Lake Sewage Plant - 8/6 months

* Estimated

SUMMARY OF AKRON-AKRON SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTENSIVE SAMPLING OPERATION DURING

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			SOLIDS % over 1/61
	Mgd.	Eff. PPM	Percent Removed	Eff. P.P.D.*	Eff. PPM	Percent Removed	Eff. P.P.D.*	
4/17/58	13.77	102	65	11723	247	37	170053	
6/19/58	11.94	96	64	11478	351	22	195600	
10/7/58	9.6	85	74	8160	553	14	174230	
5/5/59	11.41	90	82	11406	341	43	192240	
7/6/59	9.96	95	79	9884		No Samples Taken		
9/27/59	10.58	117	68	12403	411	37	213320	
12/2/59	11.65	101	73	11802	330	30	205099	
6/3/60	10.65	96	80	10254	475	5	251972	
7/18/60	9.03	92	85	8316	263	17	148226	
8/29/60	8.70	105	78	9139		No Samples Taken		
9/22/60	12.47	48	89	5987	8.4	22	86800	
4/16/61	14.09	118	55	13862	206	15	208752	
Average				11750			176935	

Failure to meet Compact requirements for Suspended Solids removal - 0/12 visits

* Estimated

DATE	RIGO Sp.	Surface Cracks Ref. Pav.	Length Ref.	Ft.*	Rut. Ref.	Depth (1 in) Ft.*	Cost per mile
4/16/59	63.24	81	67	107110	140	660020	
6/16/59	56.6	94	50	142405	151	736350	
10/16/58	55.8	83	37	126423	161	334750	
5/19/59	54.4	65	61	147423	139	374350	
6/25/59	44.0	85	82	190681	147	323360	
9/2/59	50.8	41	70	151979	93	404020	
11/12/58	45.9	82	96	189814	111	251500	
5/26/60	50.5	57	69	130814	102	258200	
7/7/60	40.2	43	71	154600	154	303510	
7/18/60	34.42	65	83	180021	142	244200	
8/17/60	37.39	...	...	...	Sample Lost	...	
5/11/61	61.8	75	57	139279	114	352250	
Average				177113		289629	

Failure to meet Compact requirements for Adequate Skid-Resi Removal - 0/11 visits

* Estimated

SUMMARY OF WILLOWBROOK HOSPITAL SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORM
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	- over
	Mgd.	PPM	Removed	P.E.*	PPM	Removed	P.E.*	1/ml
5/1/58	0.480	68	65	1361	266	15	5338	
8/25/58	0.524	71	72	1540	244	11	5400	
10/8/58	0.591	61	68	1501	250	2	7390	100
3/31/59		75	65		345	neg.		
6/23/59	0.723	79	66	2548	283	20	10091	
9/8/59	0.650	77	75	2095	258	36	8505	
11/24/59	0.632	70	55		222	neg.	7000	
5/5/60	0.710	72	66	2131	315	21	11182	
7/28/60	0.672	87	42	2430	335	5	11222	
8/11/60	0.64	71	74	1894	234	6	9480	
9/6/60	0.63	66	73	1733	321	24	10111	
6/1/61	0.647	74	65	2006	297	10	9652	
Average				1905			8289	

Failure to meet Compact requirements for Suspended Solids removal - 0/12 visits

* Estimated

Failure to meet Copper requirements for failure reversal - 6/6 valves

* Estimated
** New
*** Old

SUMMARY OF SAINT JOSEPH'S WEST PLAINS TREATMENT PLANT PERFORMANCE
FROM LABORATORY SANITARY CONDITION REPORTS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			DILUTION
		Eff. PPM	Percent Removed	Eff. P.P.M.*	Eff. PPM	Percent Removed	Eff. P.P.M.*	% over 1/20
5/22/58	----------			No Samples Taken				
7/2/59								100
8/3/60								
1961	No Visits So Far							

Failure to meet Compact requirements for coliform control - 1/1 visits

* Estimated

SUMMARY OF RICHMOND MUNICIPAL HOSPITAL SEWAGE TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION RECORDS

DATE	FLOW	SUSPENDED SOLIDS			B.O.D. (5 day)			COLIFORMS
		Eff.	Percent	Eff.	Eff.	Percent	Eff.	p over
	Mgd.	PPM	Removal	P.E.*	PPM	Removed	P.E.*	1/ml
5/22/58				No Samples Taken				100
9/16/58				"	"	"		190
5/28/59				"	"	"		108
12/3/59				"	"	"		190
8/3/60				"	"	"		160
1961	No visits so far							

Failure to meet Compact requirements for Coliform removal - 5/5 visits

* Estimated

SUMMARY OF OAKWOOD BEACH SEWER TREATMENT PLANT PERFORMANCE
FROM INTERSTATE SANITATION COMMISSION SAMPLING RECORDS

Date	Flow	Suspended Solids			B.O.D. (5 day)			Coliform
	M.G.	Eff. ppm	Percent Removal	Eff. P.P.D.*	Eff. ppm	Percent Removal	Eff. P.P.D.*	# over 1/ml
5/7/58	16.80	26	77	18114	18	61	10080	25
7/9/58	11.60	35	71	12054	10	68	5800	0
8/20/58	7.63	33	81	6158	10	88	5815	25
11/19/58	8.56	71	54	12631	10	80	7130	100
3/ 8/59	10.38	35	58	12133	16	64	13830	25
6/17/59	8.0*	30	74	9972	12	71	8000	25
7/14/59	8.0*	24	81	7993	15	72	10000	0
8/30/59	8.15	22	83	7477	17	65	11000	0
5/3/60	9.70	26	72	10518	19	61	14065	0
6/2/60	8.00	22	87	7339	25	80	16000	0
7/19/60	8.04	8	93	3008	26	72	10452	0
8/10/60	10.16	----------		Samples Lost	----------			25
11/15/60	8.95	16	84	8209	13	75	6957	25
4/11/61	14.7	25	73	11758	23	79	19305	50
5/16/61	15.9	47	74	3853	17	67	11915	50
Average				10691			9949	

Failure to meet Compact requirements for Suspended Solids removal - 2/14 visits
Failure to meet Compact requirements for Coliform removal - 2/14 visits

* Estimated